Appendix E

Vertebrate Use of Mitigation Wetlands
Ecological Assessment of Compensatory Wetland Mitigation

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October 11, 2007

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INTRODUCTION

Vertebrates are often the most visible organisms in a natural community. This section of the study examines diversity and abundance of amphibians, reptiles, mammals, and birds at 12 Iowa Department of Transportation (IDOT) wetland mitigation sites and three reference wetland areas during a two year period (2006-2007). A variety of survey methods were utilized to determine relative abundance and species diversity of vertebrates (excluding fish) inhabiting the selected wetlands. Comparisons will determine if mitigation sites are performing differently than reference wetlands for these organisms.

AMPHIBIAN USE OF MITIGATION WETLANDS

Amphibians may be the best vertebrates to study as indicators of habitat quality. Their permeable skin and dual lifestyle (aquatic and terrestrial) result in species that are particularly sensitive to environmental contaminants such as herbicides and insecticides and they inhabit both aquatic and terrestrial components of a wetland. Whereas most mammals and reptiles may live only on land and fish only in water, amphibians are a sensitive species that must find both terrestrial and aquatic habitat of a mitigation site suitable for survival and breeding. Unknown processes causing worldwide declines in amphibian species may also be occurring in Iowa.

METHODS

Frog call surveys are an important censusing method for anurans. Sites were visited after dark on nights that did not have high winds, preferably after rains. Four listening periods were established to document species that have different breeding seasons. For example, chorus frogs breed as early as March and bullfrogs do not begin calling until June. Our listening periods, derived from Iowa DNR protocols (Iowa DNR Frog and Toad Survey Instructions), were:

[April 1-21] [28 April-May 15] [May 20-June 14] [20 June-July 10]

Listeners would approach the wetland, step outside the vehicle and listen for 10 minutes. Species would be ranked from 1-3 based on the following criteria (Heyer et al, 1994; USEPA 2002):

1---individuals can be counted (space between calls)
2---calls of individuals can be distinguished, but there is some overlapping of calls
3---full chorus, constant, continuous, and overlapping

These surveys are probably the most important method to document amphibian presence. In addition, they indicate individual species and occurrence of breeding. Opportunistic netting and search of wetlands for larvae was done throughout the study. Another important censusing method was use of drift fences with pitfall traps (described in reptile section). These data were biased against treefrogs, which easily escape pitfall traps. As salamanders are mute we relied on opportunistic searching as well as minnow traps and drift fences to document their use of wetlands. On rare occasions amphibians were captured in Sherman Traps (e.g., a tiger salamander and leopard frogs at South Point).

Statistics were calculated as follows and were used for all vertebrate classes. Diversity at mitigation and reference sites was quantified using Hill's N1 (Hill 1973) as a representative measure of species diversity. Hill's N1 is given by:

$$N1 = \exp(-\sum p_i \ln(p_i)$$

where p_i is the proportion of a given species found at a site. N1 is one method of calculating the "effective number of species" (MacArthur 1965; Hill 1973). It is the exponential of the Shannon index; unlike Shannon's index, Hill's N1 represents a true diversity that behaves linearly and is therefore easier to interpret ecologically than the Shannon form (Peet 1974). Because it is derived from Shannon's index, it also has the advantage of not emphasizing either rare or common species (Jost 2006).

Because of the discrepancy in number of mitigation sites (n=12) relative to reference sites (n=3), species richness between site types was compared using expected species accumulation curves, i.e., sample-based rarefaction curves (Gotelli and Colwell 2001). Rarefaction provides a means of estimating richness, in this case species, of a subsample of data. It thus provides a way to compensate for the amount of effort expended (the sample size). In the case of this study it allows us to compare richness among multiple sites where different numbers of individuals were collected or noted. Curves were calculated using EstimateS (Version 8, Colwell 2006). This program calculates expected species accumulation and its associated 95 percent confidence intervals using the methods of Colwell et al. (2004).

RESULTS AND DISCUSSION

The greatest number of amphibian species was found at South Point (9) and the fewest at Doolittle Prairie (2). Overall mitigated wetlands harbored as many, if not more, amphibian species as reference wetlands (Table 1). The species accumulation curve for amphibians at mitigation sites (Figure 1) depicts, beginning at a sample size of approximately 1,000 individuals, a curve converging to an asymptote of 13 species. This suggests that all available species (based on predicted ranges; Christiansen and Bailey, 1991) have been found at this group of sites. Ninety five percent confidence intervals for mitigation sites overlap those of reference sites, indicating no significant difference in species richness between the two. However, at a sample size of about 190 individuals, the curve for reference sites shows signs of beginning to converge to an asymptote at an undefined level lower than that noted for mitigation sites. This suggests that although additional species remain to be recovered at reference sites, additional sampling (at reference sites) may cause the curves to diverge, with reference sites potentially being less diverse than mitigation sites.

At many of the sites, the majority of potential species occurring in the area of the site were caught, with a few notable exceptions. The southernmost sites are within the range of the smallmouth salamander (*Ambystoma texanum*); however, they were not recorded at any sites. Likewise, spring peepers (*Hyla crucifer*) and pickerel frogs (*Rana palustris*) were in the potential pool of species for the easternmost sites, but were not recorded from either mitigation or reference sites. Also of note, central newts (*Notophthalmus viridescens*) were found in the vicinity of Boevers, but none were recorded in our survey (VanDeWalle, pers. obser.).

Three species were found at all but two sites: the northern leopard frog (*Rana pipien*s) was found at all sites with the exception of Brush Creek and Grooms, the chorus

frog (*Pseudacris triseriata*) was found at all but Wickiup Hill and Mink Creek, and the bullfrog (*Rana catesbeiana*) was recorded at all but Wickiup Hill and Doolittle Prairie. Overall, there was a common suite of amphibian species with widespread distribution in central/eastern Iowa that were recorded at both reference and mitigation sites.

The only salamander species detected, the tiger salamander (*Ambystoma tigrinum*), was found at four sites (South Point, Wickiup, Dike, Engeldinger). Tiger salamanders are known to use constructed ponds and to tolerate human disturbance such as agriculture so their occurrence at both reference and mitigation wetlands was not unexpected. It was good to document them as there is anecdotal evidence that this generalist species is declining in the state.

We did not find any amphibian unique to our reference sites that could provide a rapid assessment of habitat quality. Examining reference wetlands, Engeldinger had a high diversity of amphibian species, conversely Doolittle Prairie had only two species recorded. Factors responsible for species paucity at Doolittle may include its small size and isolation from other natural habitat with no obvious source populations in the vicinity. In addition, it only held water in early spring, and for most of the year there was no standing water.

Species distribution did reflect species occurrence such as the plains leopard frog (*Rana blairi*), which was found in the southernmost wetland sites only (Jarvis, Grooms, Pleasantville, Badger Creek, South Point and Engeldinger Marsh). Distribution of some amphibians was restricted to eastern sites. There may have been spring peepers at Grooms as they were calling from a nearby wetland, and only green frogs (*Rana clamitans*) were recorded from Grooms and Palisades. Based on range, green frogs and spring peepers might have been expected at other eastern sites

Amphibians were abundant at most mitigation sites. For example, bullfrogs and cricket frogs (*Acris crepitans*) could be found at high densities at sites such as Pleasantville or South Point, and bullfrogs were common at New Hampton, as were leopard frogs at Dike. Of interest, the South Point mitigation site had higher abundance and diversity in the shallower wetlands surrounding the main wetland. This may be a result of predatory fish in the main wetland.

As an indicator of significance of these data, there is evidence that the cricket frog is disappearing from north to south in the U.S. and in Iowa (Lannoo 1998, Van Gorp 2002). We did not find this species in the northernmost wetlands (e.g., Mink Creek, New Hampton, Boevers, Hay-Buhr) and it is possible these could be recent extinctions unrelated to mitigation processes.

Additionally, there were significantly more amphibian species at newly constructed wetlands compared to older wetlands (Fig 2, $F=4.114$, $df=3$, $p=0.04$). This may be an artifact of small sample size or possibly diversity is high soon after wetlands are constructed (Chase, 2007), then competition or other factors may stabilize species composition over time.

Table 1. Number of amphibian species and effective number of amphibian species for the mitigation sites (reference wetlands are in **bold**).

Amphibians

		Effective Species	Number of Species
1	Grooms	5.59	7
2	South Point	4.96	9
5	Jarvis	4.34	6
13	**Engeldinger Marsh**	4.31	8
8	Boevers	3.94	5
12	Dike	3.43	6
3	Pleasantville	2.84	7
9	Badger Creek	2.08	6
10	Mink Creek	1.99	3
7	Wickiup Hill	1.89	2
14	**Hay-Buhr Area**	1.85	5
4	New Hampton	1.15	3
11	Brush Creek	1.13	6
6	Palisades	1.11	6
15	**Doolittle Prairie**	1.00	2

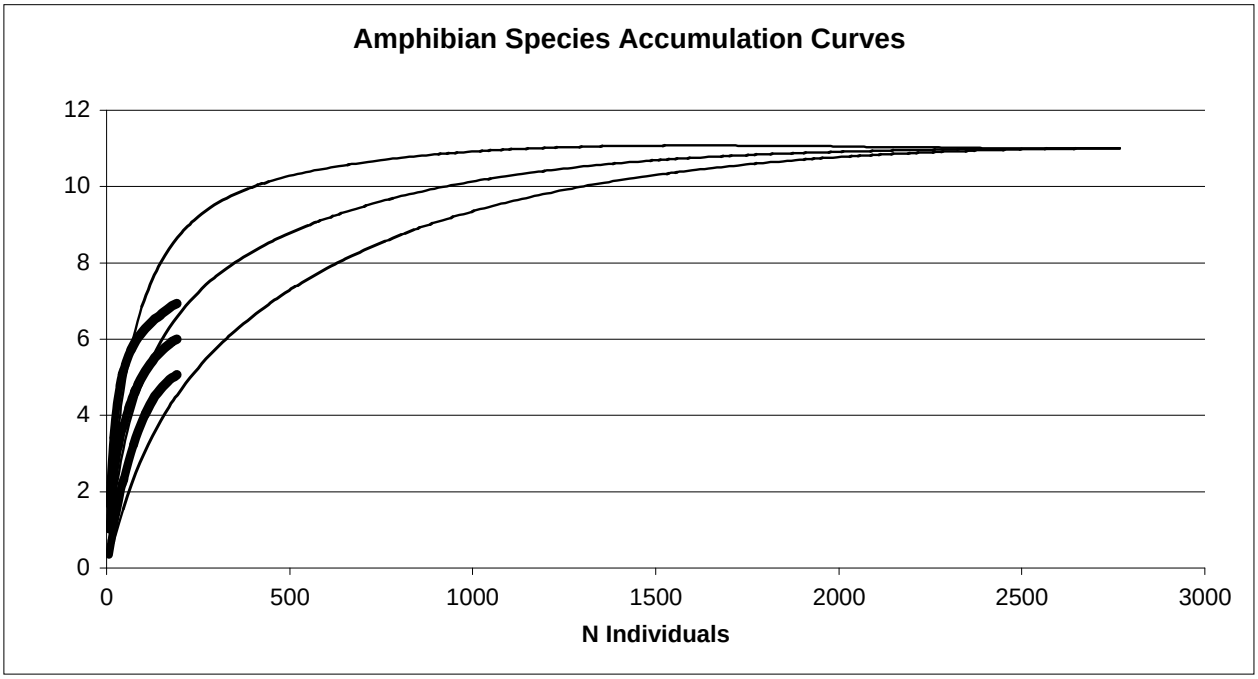

Figure 1. Species accumulation curves for amphibians. Thin lines represent mitigation sites, bold; reference. The middle line in each set of curves represents the mean, the outer pair of lines in each set represent 95% confidence intervals. If the 95% confidence intervals for the two sets overlap it indicates there is no significant difference in species richness between the two groups for that class of organisms.

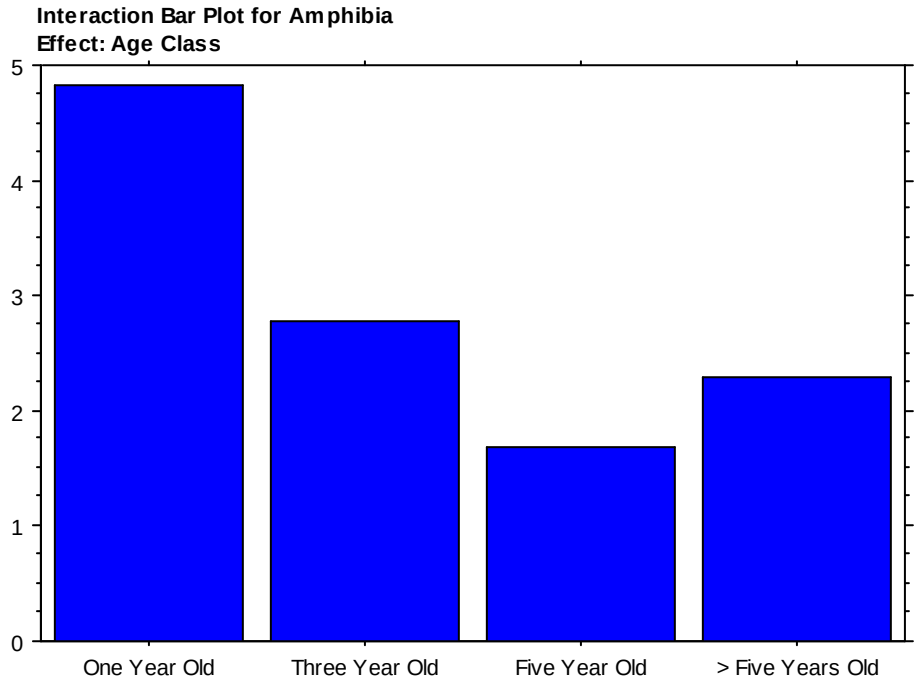

Fig. 2. Effective number of amphibian species plotted by Age class of wetland.

REPTILE USE OF MITIGATION WETLANDS

Most reptiles are not as dependent on wetlands as amphibians. Wetlands provide preferred habitat and food (frogs, fish) for semi-aquatic snakes, but neither their reproduction nor physiology demand a wetland habitat. There are 27 species of snakes in Iowa, many of which are habitat generalists, so the capture of a number of different species on wetlands is not unlikely. Semi-aquatic species such as the ribbon snake (*Thamnophis proximus*), garter snakes (*T. sirtalis* and *T. radix*), and northern water snake (*Nerodia sipedon*) would be most expected at these wetland areas and in fact they were among the most common snakes encountered. None of Iowa's five species of lizards were captured at any of the study sites during the survey. However, northern prairie skinks (*Eumeces septentrionalis*) have been previously recorded from Hay-Buhr (J. Parmelee, T. VanDeWalle, pers. observ.).

In contrast to snakes and lizards, all but one of Iowa's turtle species (the ornate box turtle, *Terrapene ornata*) are aquatic throughout much of the geographic distribution of the studied wetlands. Of these, only the snapping turtle (*Chelydra serpentina*) and painted turtle (*Chrysemys picta*) appear common in Iowa.

METHODS

Reptiles were surveyed primarily with 100 foot drift fences made of 24-36" aluminum screening with three pitfall traps made by burying five gallon buckets flush with the ground. Two drift fences were constructed in early spring at each site, one parallel to the wetland and one perpendicular in order to intersect likely travel routes of organisms. Fences were checked two trap nights per trapping period after which fences were deactivated by covering the buckets. The schedule for drift fences was:

May-June: 2 sampling periods
July: 1 sampling period
August: 1 sampling period
September: 1 sampling period

Incidental observations were also recorded during walking surveys.

In addition, turtles were also surveyed with fish baited commercial hoop turtle traps or modified fyke nets (as described by Legler et al., 1960). Aquatic turtle traps were set following the same schedule as the drift fences. Turtle traps could only be used in wetlands with enough water; several sites (e.g., Doolittle Prairie, Jarvis) never held enough water to set up a turtle trap and others (Hay Buhr, Mink Creek) became too shallow in late summer. Turtles were also observed basking on emergent logs using binoculars upon arrival at a wetland. This was conducted from a distance, as basking turtles are quite wary.

RESULTS AND DISCUSSION

Reptiles are often considered the most difficult vertebrate group to comprehensively survey. This perception is verified by the reptile species accumulation curve (Fig. 3). Figure 3 indicates no significant difference in species richness between

mitigation and reference sites (given comparable sample size). However, the mitigation sites' curve appears to be converging to an asymptote, thereby suggesting that most species have been recorded, while the reference sites' curve is not converging to an asymptote, indicating, that most likely, only the most common species have been found and that additional species may not yet have been recorded. In addition, 95 percent confidence intervals for reference sites are broad, ranging from five to 15 species for a sample size of 21 individuals (total number recovered from all reference sites). This statistic reflects both small sample size and high variability in observed reptilian species richness (one species at Engeldinger Marsh, nine at Hay-Buhr, two at Doolittle Prairie). It is likely other snake species utilize these wetlands, and only with more effort over longer periods of time would a more accurate species list for any given site be achieved.

There were only five sites where more than two reptile species were recorded; ten sites had only one or two species (Table 2). In terms of reference wetlands vs. mitigation sites, exclusive of Hay-Buhr having a remarkable diversity of reptiles, the other reference wetlands had only one or two species of reptiles. In particular, we only recorded eastern (*Thamnophis sirtalis*) or plain's (*Thamnophis radix*) garter snakes at the other two reference wetlands, making reptiles a poor choice as indicators of wetland habitat quality. Reptiles, as a group, are probably facultative in wetland use, and it may be that surrounding habitat is a more important variable.

Hay-Buhr, a reference wetland, had the greatest diversity of reptiles. Most notable are several relatively rare in Iowa: the eastern massasauga rattlesnake (*Sistrurus catenatus*), Blanding's turtle (*Emydoidea blandingii*), Graham's crawfish snake (*Regina grahamii*), and smooth green snake (*Lioclonorophis vernalis*) were all found at this wetland. This is an area of remarkably high reptile diversity in the state. The next highest reptile diversity sites were Badger Creek and South Point. Both of these were large mitigation sites with considerable habitat heterogeneity. They both had the two common turtles, snapping and painted turtles. In addition, Badger Creek had three species of garter snake (eastern, plains, ribbon snake [*Thamnophis proximus*]) as well as a racer (*Coluber constrictor*) and fox snake (*Elaphe vulpina*). South Point had two species of garter snakes (eastern and plain's) and the brown snake (*Storeria dekayi*).

The eastern garter snake was the most common snake recorded at any site, and if only one snake species was recorded at a site, it was usually this species. It was somewhat surprising that northern water snakes (*Nerodia sipedon*) were only found at Hay-Buhr, Grooms and Jarvis. This species is common at historically permanent bodies of water throughout eastern/central Iowa and many of the wetlands in this study may have been too ephemeral for them as they rely primarily upon aquatic prey.

For turtles, we expected snapping turtles and painted turtles (*Chrysemys picta*) at all sites. The only other turtle recorded was the Blanding's turtle (*Emydoidea blandingii*), found at Hay-Buhr. A Blanding's turtle was also found at Doolittle prairie in 2007 (a year after our survey) by Bill Clark, a biologist at Iowa State University (pers.comm., J. Parmelee). There was considerably more water present at Doolittle in 2007, and there is a previously recorded population of this species located only 1.6 kilometers away (Iowa Natural Areas Inventory Database, 2007). Therefore, it is possible that a small population of Blanding's turtles utilizes Doolittle Prairie during wet periods. This species is indicative of a healthy wetland habitat, and the fact that it was only found in the reference wetlands might indicate that mitigation sites are unsuitable for this

species or, more likely, there was no suitable source population present when the wetland was constructed.

There were more reptile species in larger wetlands compared to smaller wetlands (Fig. 4, $F=8.525$, $df=1,13$, $p=0.01$). This was the only vertebrate group with a significant relationship between size of wetland and species richness, and we are not sure why we only found this relationship with reptiles. However, the Hay-Buhr and Badger Creek were both relatively large compared the other sites with heterogenous habitat, and, in the latter case, there was little disturbance of habitat during wetland construction.

These species were found in most of the reference and mitigated wetlands where there was sufficient permanent water.

Table 2. Number of reptile species and effective number of reptile species for the mitigation sites (reference wetlands are in **bold**).

Reptiles

		Effective Species	Number of Species
14	**Hay-Buhr Area**	7.56	9
9	Badger Creek	5.86	7
2	South Point	4.46	5
1	Grooms	2.83	3
11	Brush Creek	2.05	4
4	New Hampton	2.00	2
5	Jarvis	1.89	2
7	Wickiup Hill	1.89	2
3	Pleasantville	1.75	2
15	**Doolittle Prairie**	1.75	2
6	Palisades	1.51	2
10	Mink Creek	1.00	1
12	Dike	1.00	1
13	**Engeldinger Marsh**	1.00	1
8	Boevers	1.00	1

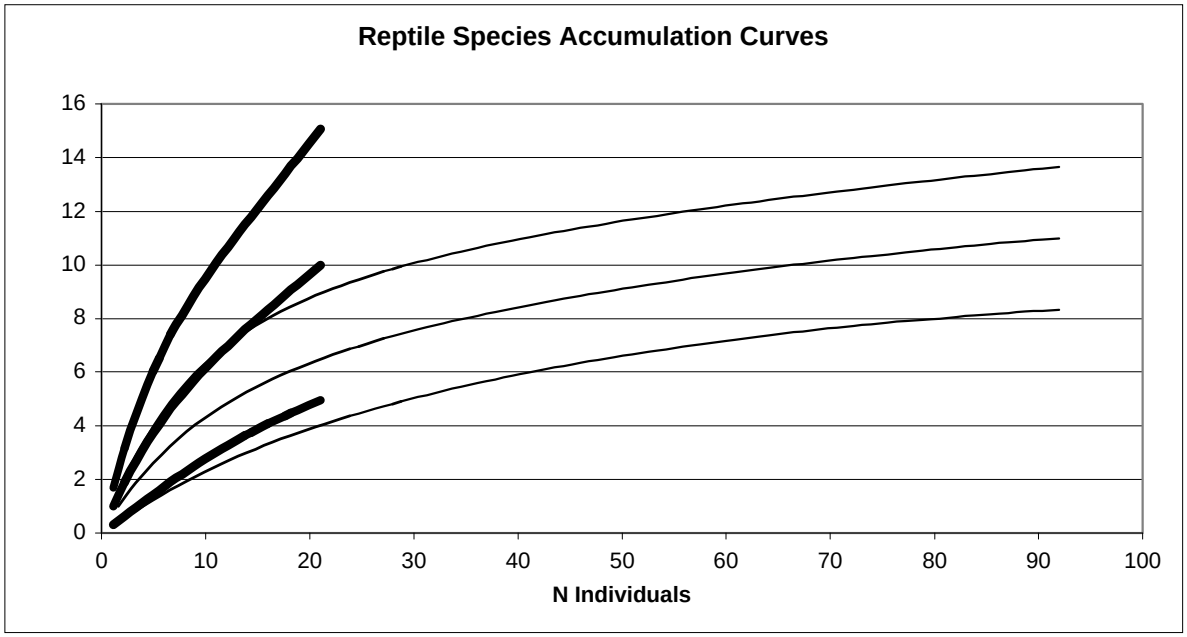

Figure 3. Species accumulation curves for reptiles. Thin lines represent mitigation sites, bold; reference. The middle line in each set of curves represents the mean, the outer pair of lines in each set represent 95% confidence intervals. If the 95% confidence intervals for the two sets overlap it indicates there is no significant difference in species richness between the two groups for that class of organisms.

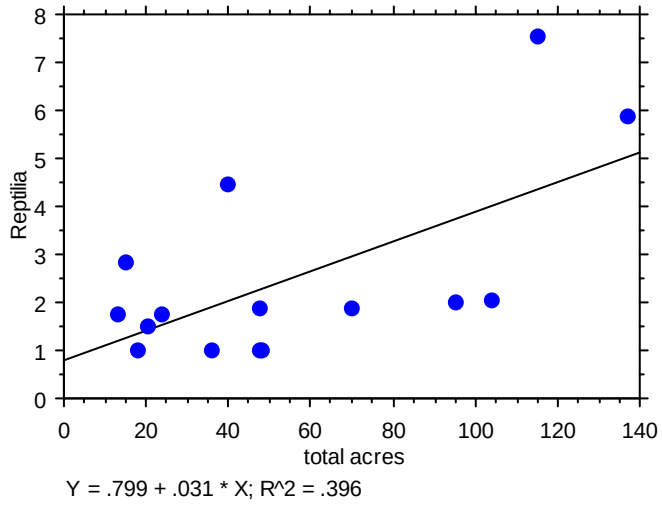

Figure 4. Number of effective reptile species vs. size of wetland.

MAMMAL USE OF MITIGATION WETLANDS

Unlike amphibians, most mammals are facultative inhabitants of wetland areas and are typically found in surrounding upland habitat. As such, they are not direct indicators of wetland quality. Instead, they are useful indicators of overall habitat or landscape quality. Their inclusion in this study was justified by the fact that a wetland does not stand alone but is surrounded by supporting habitats and communities, they are surveyed relatively easily, and often times may serve as general indicators of habitat quality. Of particular importance to this study are those species that appear to be declining in numbers in Iowa (Iowa Comprehensive Wildlife Conservation Plan, 2007) and other parts of the upper Midwest including the southern bog lemming (*Synaptomys cooperi*), prairie vole (*Microtus ochrogaster*), Franklin's ground squirrel (*Spermophilus franklinii*), and least shrew (*Cryptotis parva*).

METHODS

Mammals were surveyed using Sherman live traps baited with rolled oats, drift fences, and visual observation. Forty traps/site were set out in linear trap-lines with the goal of sampling different environments at each location. Traps were deployed following the same schedule as drift fences (described in reptile section).

RESULTS AND DISCUSSION

Mammalian species diversity and other values were similar across all sights with no significant difference between mitigation and reference sites. The species accumulation curve for mammals (Fig. 5) shows no significant difference in species richness between mitigation reference sites, given comparable sample sizes, but the curve for mammals at mitigation sites appears to be converging to an asymptote of approximately 25 species. This convergence suggests that all common and most rare species have been recorded. The curve for reference sites does not appear to converge to an asymptote, indicating that additional species may not yet have been recorded.

Small mammal species were remarkably consistent site to site (Table 3: X = 8.73, range 6-13) with most variation due to incidental sightings such as rabbits, deer and meso-carnivores. Effective number of mammalian species, a measure of diversity, was calculated for each site as described in the amphibian methods section. Again, values were relatively consistent across sites (Table 3: X = 4.89, range 2.31-6.97) with no noticeable difference between reference and mitigation sites. These represent organisms that were likely present, at least in a transient fashion at all sights, but were not always noted. It is interesting to note that sites having the highest number of species reported were all mitigation sites (Grooms, South Point, Pleasantville, Mink Creek). All but Mink Creek were in the southern portion of the study area. The following two species were found at all sights deer/white-footed mouse (due to difficulty in field identification, particularly juveniles, these two species were not always well differentiated) and meadow vole. Masked and short-tailed shrews were found at all sites except for Hay-Buhr. Other species found at most sites were the western harvest mouse and meadow jumping mouse. The above noted organisms can be classified, somewhat, as generalist type species and are found throughout Iowa and the Upper Midwest in a variety of habitats. No correlation between size of wetland area and number of mammalian species was detected.

When prairie voles (*Microtus ochrogaster*) were detected, they were locally common and primarily in the southern sites, and long-tailed weasel (*Mustela frenata*) was more common in the northern sites while the short-tailed weasel (*N. nivalis*) was found in the southern sites.

Table 3. Total number of mammal species and effective number of mammal species for the mitigation sites (reference wetlands are in **bold**).

Mammals

		Effective Species	Number of Species
3	Pleasantville	6.97	12
14	**Hay-Buhr Area**	6.73	8
12	Dike	6.35	11
8	Boevers	6.25	8
7	Wickiup Hill	6.02	7
10	Mink Creek	6.01	9
13	**Engeldinger Marsh**	5.25	9
2	South Point	4.66	13
1	Grooms	4.48	11
9	Badger Creek	4.20	8
11	Brush Creek	4.12	8
15	**Doolittle Prairie**	4.06	6
6	Palisades	3.52	6
4	New Hampton	2.47	7
5	Jarvis	2.31	8

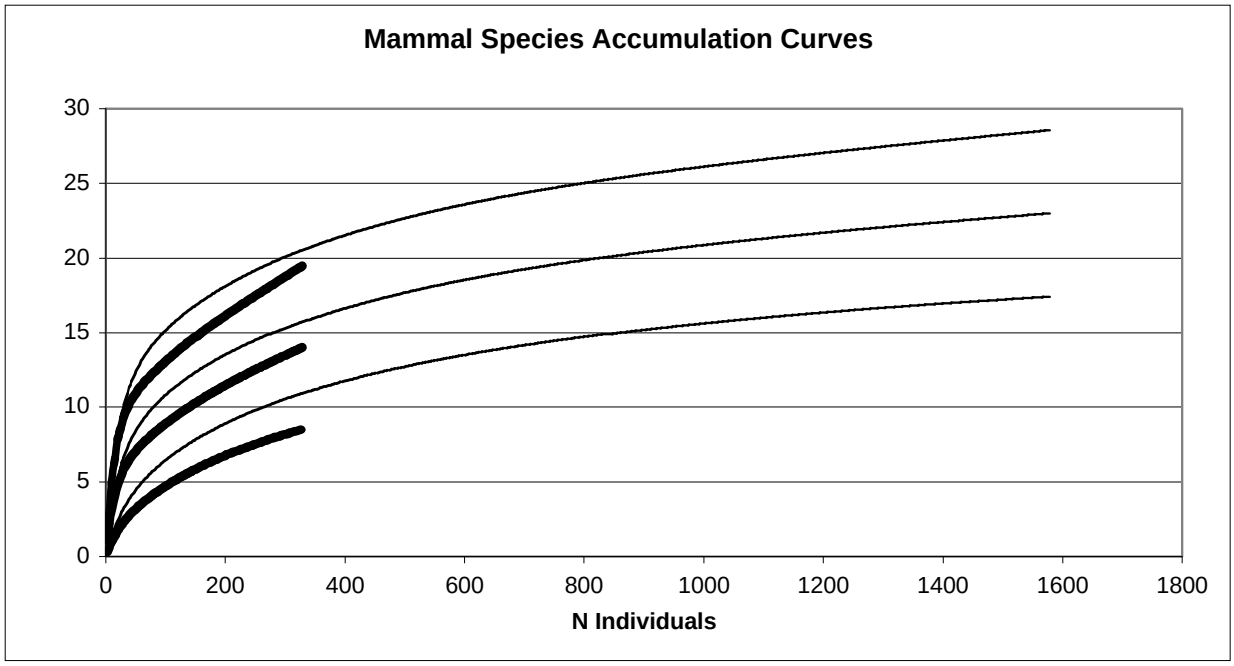

Figure 5. Species accumulation curves for mammals. Thin lines represent mitigation sites, bold; reference. The middle line in each set of curves represents the mean, the outer pair of lines in each set represent 95% confidence intervals. If the 95% confidence intervals for the two sets overlap it indicates there is no significant difference in species richness between the two groups for that class of organisms.

BIRD USE OF MITIGATION WETLANDS

Bird use of mitigation sites falls into two categories, breeding birds that use the wetlands for reproduction and migratory birds where the wetlands serve as a feeding and resting area along their migratory routes. Birds were by far the most diverse vertebrate group at the wetlands. This may be a consequence of them being the most speciose vertebrate group in Iowa.

METHODS

Migratory and breeding birds were censused within 4 hours of sunrise, during winds under 32 km/h, and during times of no precipitation. Migratory waterfowl were surveyed once between 15-31 March and between 15-25 October from observations overlooking the wetlands.

The breeding bird communities were surveyed during four periods: 20 May-5 June, 6 June-22 June, 23 June -7 July, 15 July -7 August. Each wetland was censused once during each period. Upland breeding birds were counted at survey points 100 m apart. At each point, the observer waited for 1 minute after arrival, conducted a 10 minute count of birds seen or heard, and noted birds within a 30 m radius and a 30-50 m radius from the survey point. Gender of the bird was noted as was behaviors such as singing, perching, sitting, or territorial defense. Flyovers were not counted.

The wetland breeding birds were censused in a similar manner, except that survey points were spaced 100 m along the shoreline of the wetland. Following the upland count of birds seen or heard, a 10 minute audio tape of calls by Virginia rails, yellow rails, black rails, sora rails, American bittern, and least bittern was also played. Number of vocalizations and location of the vocalization were noted, and any visual confirmations of birds that responded to the tape were noted. After the tape was played once and responses were counted, there was a one minute silence, and the process repeated.

RESULTS AND DISCUSSION

The species accumulation curves for birds (Fig. 6) again show no significant difference in species richness between mitigation and reference sites given comparable sample sizes. In addition, as more individuals are recovered, the number of species for both mitigation and reference sites do not appear to be converging to an asymptote, indicating that, in both cases, additional species may not yet have been recorded.

The five most common species sighted, in order, were red-winged blackbird (281), common yellowthroat (143), song sparrow (130), American goldfinch (113) and killdeer (77). All are common in Iowa, and, with the exception of killdeer, none are dependent upon wetlands. In addition, while killdeer prefer wetlands, they can exist in other habitats. Of the birds detected, the number of wetland species compared to the total number of species recorded at a site averaged 23.2%. Three sites had no wetland-dependent birds (Grooms, Jarvis, and Doolittle). It is noteworthy that Doolittle, as a reference, was considered a natural wetland site. Five sites stood out for their higher percentage of wetland-dependent birds: Mink Creek (47%), Dike (44%), Palisades

(43%), and New Hampton (40%). Engeldinger Marsh and Hay-Buhr, the other reference wetlands, had 32% and 19%, respectively. The percentage of wetland-dependent birds would decrease if migratory wetland birds were eliminated from the analysis. Therefore, for nesting species, the sites were dominated by upland birds, not wetland species.

The above data seem contradictory to data indicating Wickiup Hill had the highest number of effective species (Table 4). This statistic was skewed by the presence of a nesting pair of osprey. The occurrence of osprey had two major effects on the Wickiup Hill data. First, because of their rarity, the calculation of effective number of species would result in a high statistic. Second, although osprey are almost exclusively fish eaters, other birds typically sense the presence of a predator and, therefore, avoid the area. Census at Wickiup Hill was also complicated by the lack of water during much of the year. In general, the effective number of species provides limited meaning for birds and virtually none for assessing presence of wetland-dependent species. As examples, Grooms and Jarvis had relatively high statistics for effective numbers, but, as noted, no wetland-dependent birds. Wickiup Hill had only 16% of sightings that were wetland-dependent birds, and although nesting osprey typically tend to be rare, the Linn County Conservation Department had been hacking captive-raised osprey in the area for several years prior to our survey.

A positive effect was the usage of the wetlands by migratory birds. Conservatively, at least 85 of 157 (54%) wetland species sighted (not number of different species) were migrants. To be clear, if a mallard was sighted at two wetlands, that would be two sightings for a single species.

Table 4. Number of bird species and effective number of bird species for the mitigation sites (reference wetlands are in **bold**).

Birds

		Effective Species	Number of Species
7	Wickiup Hill	18.02	26
14	**Hay-Buhr Area**	17.41	70
1	Grooms	16.61	27
11	Brush Creek	15.97	39
4	New Hampton	15.01	45
5	Jarvis	14.85	36
10	Mink Creek	12.28	53
2	South Point	11.28	41
8	Boevers	10.92	25
13	**Engeldinger Marsh**	10.86	28
6	Palisades	8.33	35
15	**Doolittle Prairie**	8.19	15
12	Dike	7.88	41
9	Badger Creek	7.74	19
3	Pleasantville	4.82	17

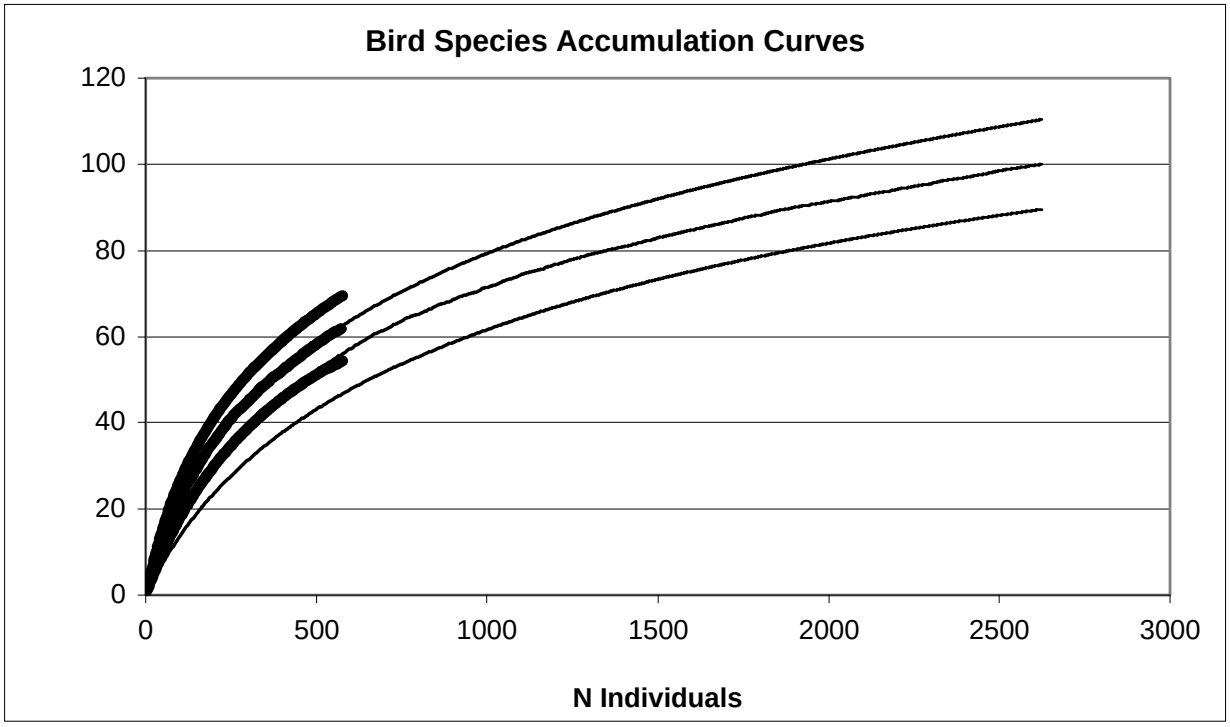

Figure 6. Species accumulation curves for birds. Thin lines represent mitigation sites, bold; reference. The middle line in each set of curves represents the mean, the outer pair of lines in each set represent 95% confidence intervals. If the 95% confidence intervals for the two sets overlap it indicates there is no significant difference in species richness between the two groups for that class of organisms.

CONCLUSIONS

Overall, data from this study support the conclusion that mitigation sites function in a similar fashion to reference wetlands. On average, wetlands (reference and mitigated) harbored approximately 5 amphibian species, 3 reptile species, 5 mammal species, and 35 bird species (Table 5). Based on species accumulation curves, we believe reptiles and birds are probably underestimated in our survey whereas additional survey time would probably yield only a few more amphibian or mammalian species.

When sorted by vertebrate diversity the three reference wetlands showed no clear pattern, coming out on top, in the middle, and at the low end of the diversity spectrum (Table 5). This indicates other factors may be more important to vertebrate diversity than whether the wetland was natural or mitigated (created or restored). Two of these factors appear to be size and habitat heterogeneity. Larger areas and more diversity of habitats should contribute to higher diversity and data indicate a trend but it was not a statistically significant relationship (Figs. 8 and 9). Larger wetlands did hold more species of vertebrates, but this was not significant for either total species (Fig 7, F=2.510, df=1,13, p=0.14) or total effective number of species (Fig. 8, F=1.341, df=1,13, p=0.27)

When separating out vertebrate groups, only reptiles showed a significant positive relationship between wetland area and species richness. Amphibians and birds had a positive but non-significant trend toward greater species diversity in larger wetlands. Mammals showed no trend at all.

Age of wetland was correlated with species diversity only for amphibians with a surprisingly greater diversity noted at the newly created wetlands. Overall, species diversity was greatest at the newly constructed wetlands, primarily due to amphibians, (×=25.7 species), with 20.1 species at the 3 year old sites, 20.7 at the 5 year old sites, and 22.2 species at the sites over 5 years old (Fig. 9).

Based on these data and the geographical location of the sites, we suspect that proximity and connectivity to existing populations of vertebrates is an important determinant in what species will be present at a mitigated wetland. Birds, which are more mobile than other vertebrates, are probably less affected by these parameters.

Table 5. Diversity of vertebrate species found at wetlands sites in 2006-2007 sorted by numbers of effective species. Reference areas are in **bold**.

Numbers of Effective Species

(Measure of Diversity)

	Unweighted Numbers									Total	All
		Amphibia	# Species	Aves	# Species	Mammalia	# Species	Reptilia	# Species	Sp. #	Vertebrates
14	**Hay-Buhr Area**	1.85	5	17.41	70	6.73	8	7.56	9	92	33.56
1	Grooms	5.59	7	16.61	27	4.48	11	2.83	3	48	29.50
7	Wickiup Hill	1.89	2	18.02	26	6.02	7	1.89	2	37	27.82
2	South Point	4.96	9	11.28	41	4.66	13	4.46	5	68	25.36
5	Jarvis	4.34	6	14.85	36	2.31	8	1.89	2	52	23.39
11	Brush Creek	1.13	6	15.97	39	4.12	8	2.05	4	57	23.25
8	Boevers	3.94	5	10.92	25	6.25	8	1.00	1	39	22.10
13	**Engeldinger Marsh**	4.31	8	10.86	28	5.25	9	1.00	1	46	21.42
10	Mink Creek	1.99	3	12.28	53	6.01	9	1.00	1	66	21.28
4	New Hampton	1.15	3	15.01	45	2.47	7	2.00	2	57	20.63
9	Badger Creek	2.08	6	7.74	19	4.20	8	5.86	7	40	19.87
12	Dike	3.43	6	7.88	41	6.35	11	1.00	1	59	18.66
3	Pleasantville	2.84	7	4.82	17	6.97	12	1.75	2	38	16.39
15	**Doolittle Prairie**	1.00	2	8.19	15	4.06	6	1.75	2	25	15.01
6	Palisades	1.11	6	8.33	35	3.52	6	1.51	2	49	14.46
	Average Diversity	2.77	5.4	12.01	34.5	4.89	8.7	2.50	2.9		

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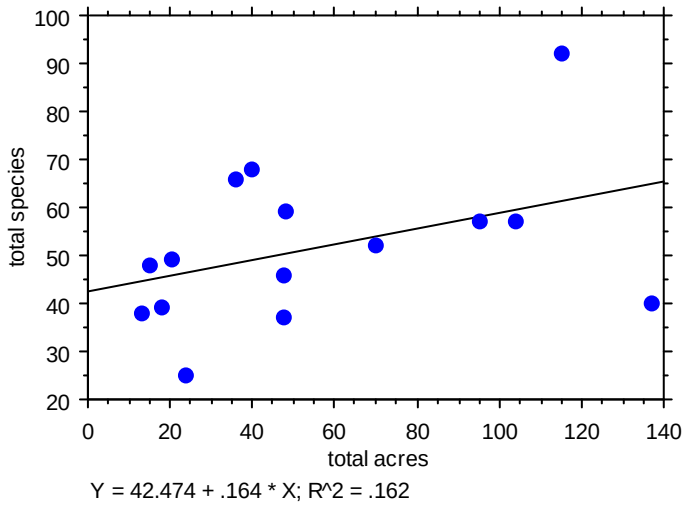

Figure 7. Total species vs. total acres of the wetlands

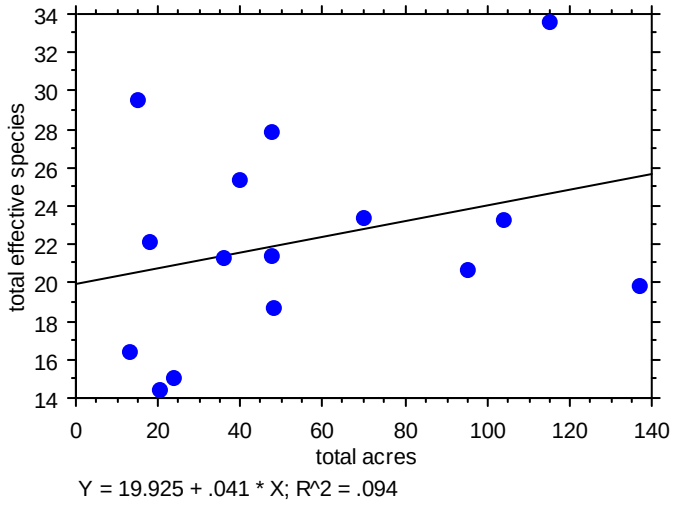

Figure 8. Total effective species vs. total acres of the wetlands.

ANOVA Table for total effective species

	DF	Sum of Squares	Mean Square	F-Value	P-Value	Lambda	Power
Age Class	3	55.177	18.392	.598	.6297	1.793	.135
Residual	11	338.575	30.780				

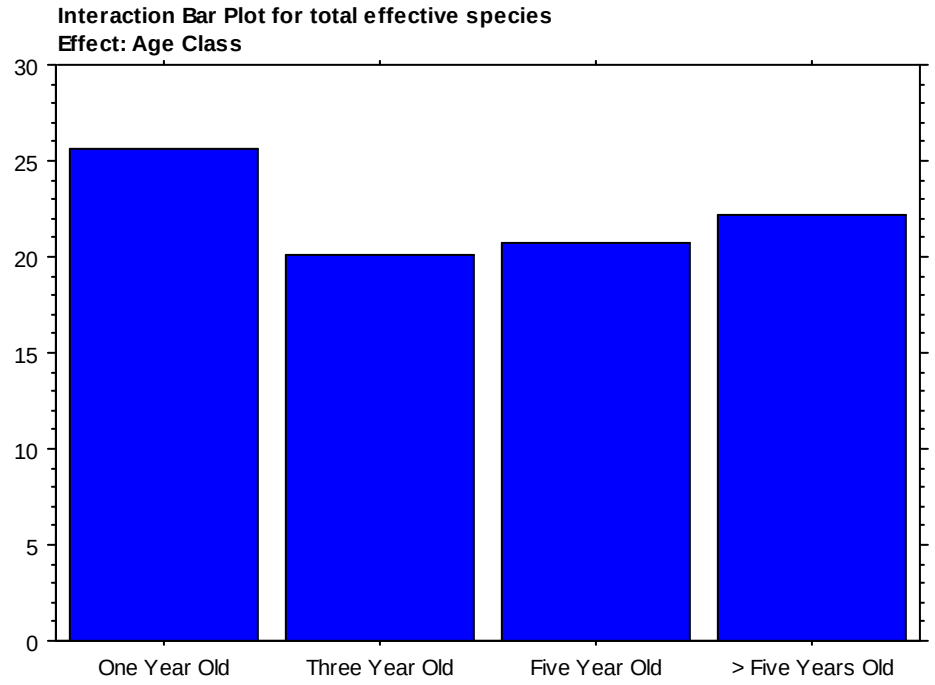

Fig. 9. Effective number of species at four age classes of wetlands.

RECOMMENDATIONS

Data indicate that the wetland mitigation sites examined appear to function well for vertebrate species. Although it is never desirable to destroy wetlands, results support the role of mitigation sites as useful refugia for vertebrates, particularly migratory waterfowl, in Iowa. In general, the larger and more heterogeneous the wetland the better. Mitigation sites should be constructed with these parameters in mind in order to increase species diversity. It is also important to preserve land surrounding the actual wetland as most vertebrates we noted were not physically within the wetland, and even those that were, such as the turtles, need some terrestrial habitat for reproduction and dispersal. It is also important that, whenever possible, mitigation sites be connected, *via* habitat corridors, to other appropriate habitat in order to reduce effects of isolation. Results of this study indicate that while in most, if not all, cases diversity was not increased for most vertebrate groups within a mitigated wetland, it was at least representative of the regional diversity as indicated by reference sites. This is likely due to the vast and rapid conversion of the Iowa landscape to agriculture within the course of a generation (> 90 wetland loss, Dinsmore, 1994)

It is recommended that fish not be stocked in wetlands and water levels maintained at levels low enough to discourage fish survival. Exclusive of bullfrogs (non-

native in much of their current distribution), most amphibians are incompatible with fish, as fish eat eggs and larvae.

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Appendix 1. List of species in each vertebrate group at each wetland site in order of adundance as measured by number of entries. The number of entries is the number of visits where this species was recorded.

Grooms

48 vertebrate species			entries
Amphibians	Plains Leopard Frog	*Rana blairi*	7
7 species	Cricket Frog	*Acris crepitans*	6
	American Toad	*Bufo americanus*	5
	Gray Treefrog	*Hyla versicolor*	5
	Western Chorus Frog	*Pseudacris triseriata*	5
	Green Frog	*Rana clamitans*	5
	Bullfrog	*Rana catesbeiana*	2
Reptiles	Northern Water Snake	*Nerodia sipedon*	2
3 species	Snapping Turtle	*Chelydra serpentina*	1
	Western Ribbon Snake	*Thamnophis proximus*	1
Birds	Song Sparrow	*Melospiza melodia*	10
27 species	Common Yellowthroat	*Geothlypis trichas*	9
	House Wren	*Troglodytes aedon*	9
	Red-winged Blackbird	*Agelaius phoeniceus*	8
	Gray Catbird	*Dumetella carolinensis*	5
	Grasshopper Sparrow	*Ammodramus savannarum*	4
	Blue Jay	*Cyanocitta cristata*	4
	American Goldfinch	*Carduelis tristis*	3
	Killdeer	*Charadrius vociferus*	3
	Dickcissel	*Spiza americana*	3
	American Robin	*Turdus migratorius*	3
	Mourning Dove	*Zenaida macroura*	3
	Northern Cardinal	*Cardinalis cardinalis*	2
	Indigo Bunting	*Spizella passerina*	2
	Eastern Meadowlark	*Sturnella magna*	2
	Eastern Kingbird	*Tyrannus tyrannus*	2
	Warbling Vireo	*Vireo gilvus*	2
	Ruby-throated Hummingbird	*Archilochus colubris*	1
	Northern Flicker	*Colaptes auratus*	1
	Cliff Swallow	*Petrochelidon pyrrhonota*	1
	Orchard Oriole	*Icterus spurius*	1
	Great Crested Flycatcher	*Myiarchus crinitus*	1

	Savannah Sparrow	*Passerculus sandwichensis*	1
	Common Grackle	*Quiscalus quiscula*	1
	Field Sparrow	*Spizella pusilla*	1
	Northern Rough-winged Swallow	*Stelgidopteryx ruficollis*	1
	Bell's Vireo	*Vireo bellii*	1
Mammals	Deer/White-footed Mouse	*Peromyscus spp.*	18
11 species	Meadow Vole	*Microtus pennsylvanicus*	6
	Masked Shrew	*Sorex cinereus*	6
	Eastern Chipmunk	*Tamias striatus*	6
	Prairie Vole	*Microtus ochrogaster*	5
	Short-tailed Shrew	*Blarina brevicauda*	4
	Western Harvest Mouse	*Reithrodontomys megalotis*	4
	Meadow Jumping Mouse	*Zapus hudsonicus*	3
	White-tailed Deer	*Odocoileus virginianus*	2
	Eastern Cottontail Rabbit	*Sylvilagus floridanus*	2
	Least Weasel	*Mustela nivalis*	1

South Point

68 vertebrate species

			entries
Amphibians	Northern Leopard Frog	*Rana pipiens*	17
9 species	Bullfrog	*Rana catesbeiana*	11
	American Toad	*Bufo americanus*	9
	Cricket Frog	*Acris crepitans*	8
	Plain's Leopard Frog	*Rana blairi*	7
	Western Chorus Frog	*Pseudacris triseriata*	6
	Cope's Gray Treefrog	*Hyla chrysoscelis*	5
	Tiger Salamander	*Ambystoma tigrinum*	3
	Tree Frog (sp.)	*Hyla* sp.	2
Reptiles	Eastern Garter Snake	*Thamnophis sirtalis*	7
5 species	Snapping Turtle	*Chelydra serpentina*	3
	Plains Garter Snake	*Thamnophis radix*	3
	Painted Turtle	*Chrysemys picta*	2
	Brown Snake	*Storeria dekayi*	2
Birds	Red-winged Blackbird	*Agelaius phoeniceus*	22
41 species	Song Sparrow	*Melospiza melodia*	8
	Northern Oriole	*Icterus galbula*	5
	Green Heron	*Butorides virescens*	4
	American Goldfinch	*Carduelis tristis*	4
	Killdeer	*Charadrius vociferus*	4
	Northern Shoveler	*Anas clypeata*	3
	Ring-necked Duck	*Aythya collaris*	3
	Canada Goose	*Branta canadensis*	3
	Common Grackle	*Quiscalus quiscula*	3
	Dickcissel	*Spiza americana*	3
	Indigo Bunting	*Passerina cyanea*	2
	Blue-winged Teal	*Anas discors*	2
	Mallard	*Anas platyrhynchos*	2
	Great Blue Heron	*Ardea herodias*	2
	Great Egret	*Casmerodius albus*	2
	American Tree Sparrow	*Spizella arborea*	2
	Tree Swallow	*Tachycineta bicolor*	2
	American Robin	*Turdus migratorius*	2

	Shart-shinned Hawk	*Accipiter striatus*	1
	Spotted Sandpiper	*Actitis macularia*	1
	Grasshopper Sparrow	*Ammodramus savannarum*	1
	American Widgeon	*Anas americana*	1
	Gadwall	*Anas streptera*	1
	Scaup	*Aythya sp.*	1
	Northern Cardinal	*Cardinalis cardinalis*	1
	Belted Kingfisher	*Ceryle alcyon*	1
	Sedge Wren	*Cistothorus platensis*	1
	American Crow	*Corvus brachyrhynchos*	1
	Horned Lark	*Eremophila alpestris*	1
	American Coot	*Fulica americana*	1
	Common Yellowthroat	*Geothlypis trichas*	1
	Barn Swallow	*Hirundo rustica*	1
	Hooded Merganser	*Lophodytes cucullatus*	1
	Rose-breasted Grosbeak	*Pheucticus ludovicianus*	1
	Pied-billed Grebe	*Podilymbus podiceps*	1
	Eastern Meadowlark	*Sturnella magna*	1
	Eastern Kingbird	*Tyrannus tyrannus*	1
	Red-eyed Vireo	*Vireo olivaceus*	1
	Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	1
	Mourning Dove	*Zenaida macroura*	1
Mammals	Meadow Vole	*Microtus pennsylvanicus*	16
13 species	Deer/White-footed Mouse	*Peromyscus* spp.	15
	Western Harvest Mouse	*Reithrodontomys megalotis*	10
	Prairie Vole	*Microtus ochrogaster*	8
	Masked Shrew	*Sorex cinereus*	8
	Short-tailed Shrew	*Blarina brevicauda*	4
	Meadow Jumping Mouse	*Zapus hudsonius*	3
	Beaver	*castor canadensis*	1
	Bobcat	*Felis rufus*	1
	White-tailed Deer	*Odocoileus virginianus*	1
	Racoon	*Procyon lotor*	1
	Eastern Cottontail	*Sylvilagus floridanus*	1
	Badger	*Taxidea taxus*	1

Pleasantville

38 vertebrate species

			entries
Amphibians	Bullfrog	*Rana catesbeiana*	17
7 species	Cricket Frog	*Acris crepitans*	12
	American Toad	*Bufo americanus*	4
	Gray Treefrog	*Hyla versicolor*	4
	Western Chorus Frog	*Pseudacris triseriata*	3
	Northern Leopard Frog	*Rana pipiens*	2
	Plain's Leopard Frog	*Rana blairi*	1
Reptiles	Eastern Garter Snake	*Thamnophis sirtalis*	3
2 species	Snapping Turtle	*Chelydra serpentina*	1
Birds	Red-winged Blackbird	*Agelaius phoeniceus*	21
17 species	American Goldfinch	*Carduelis tristis*	6
	Common Yellowthroat	*Geothlypis trichas*	6
	Song Sparrow	*Melospiza melodia*	4
	Eastern Kingbird	*Tyrannus tyrannus*	4
	Canada Goose	*Branta canadensis*	3
	Mallard	*Anas platyrhynchos*	2
	Great Blue Heron	*Ardea herodias*	2
	Belted Kingfisher	*Ceryle alcyon*	2
	Common Grackle	*Quiscalus quiscula*	2
	Northern Shoveler	*Anas clypeata*	1
	Ruby-throated Hummingbird	*Archilocus colubris*	1
	Killdeer	*Charadrius vociferus*	1
	American Coot	*Fulica americana*	1
	Eastern Meadowlark	*Sturnella magna*	1
	Brown Thrasher	*Toxostoma rufum*	1
	Lesser Yellowlegs	*Tringa flavipes*	1
Mammals	Meadow Vole	*Microtus pennsylvanicus*	15
12 species	Deer/White-footed Mouse	*Peromyscus spp.*	12
	Prairie Vole	*Microtus ochrogaster*	6
	Masked Shrew	*Sorex cinereus*	6
	Short-tailed Shrew	*Blarina brevicauda*	5
	Western Harvest Mouse	*Reithrodontomys megalotis*	4
	Muskrat	*Ondatra zibethicus*	3
	Meadow Jumping Mouse	*Zapus hudsonius*	3
	White-tailed Deer	*Odocoileus virginianus*	2

Domestic (Feral) Cat	*Felis catus*	1
Least Weasel	*Mustela nivalis*	1
Racoon	*Procyon lotor*	1

New Hampton

57 vertebrate species

			entries
Amphibians	Bullfrog	*Rana catesbeiana*	5
3 species	Northern Leopard Frog	*Rana pipiens*	5
	Western Chorus Frog	*Pseudacris triseriata*	2
	Bullfrog (tadpole)	*Rana catesbeiana*	2
Reptiles	Snapping Turtle	*Chelydra serpentina*	1
2 species	Painted Turtle	*Chrysemys picta*	1
Birds	Killdeer	*Charadrius vociferus*	18
45 species	Red-winged Blackbird	*Agelaius phoeniceus*	17
	Spotted Sandpiper	*Actitis macularia*	13
	Common Grackle	*Quiscalus quiscula*	13
	Barn Swallow	*Hirundo rustica*	12
	Mourning Dove	*Zenaida macroura*	12
	Green Heron	*Butorides virescens*	11
	Wood Duck	*Aix sponsa*	10
	Song Sparrow	*Melospiza melodia*	10
	American Goldfinch	*Carduelis tristis*	9
	Grasshopper Sparrow	*Ammodramus savannarum*	8
	Mallard	*Anas platyrhynchos*	8
	American Crow	*Corvus brachyrhnchos*	8
	Savannah Sparrow	*Passerculus sandwichensis*	8
	Eastern Meadowlark	*Sturnella magna*	8
	Great Blue Heron	*Ardea herodius*	7
	Bobolink	*Dolichonyx oryzivorous*	7
	Tree Swallow	*Tachycineta bicolor*	7
	Blue-winged Teal	*Anas discors*	6
	Cedar Waxwing	*Bombycilla cedrorum*	6
	Canada Goose	*Branta canadensis*	6
	Eastern Kingbird	*Tyrannus tyrannus*	6
	Belted Kingfisher	*Ceryle alcyon*	5
	Dickcissel	*Spiza americana*	5
	Red-tailed Hawk	*Buteo jamaicencis*	4
	Marsh Wren	*Cistothorus palustris*	4
	Sedge Wren	*Cistothorus platensis*	4
	Lesser Yellowlegs	*Tringa flavipes*	4
	Cliff Swallow	*Petrochelidon pyrrhonota*	3
	Northern Shoveler	*Anas clypeata*	2
	Ring-necked Duck	*Aythya collaris*	2

	Pectoral Sandpiper	*Caladris melanotos*	2
	Chimney Swift	*Chaetura pelagica*	2
	Brown-headed Cowbird	*Molothrus ater*	2
	Sora	*Porzana carolina*	2
	American Robin	*Turdus migratorius*	2
	American Widgeon	*Anas americana*	1
	Green-winged Teal	*Anas crecca*	1
	Gadwall	*Anas strepera*	1
	Blue Jay	*Cyanocitta cristata*	1
	Common Yellowthroat	*Geothlypis trichas*	1
	Hooded Merganser	*Lophodytes cucullatus*	1
	Lincoln Sparrow	*Melospiza lincolnii*	1
	Ring-necked Pheasant	*Phasianus colchicus*	1
	European Starling	*Sturnus vulgaris*	1
Mammals	Meadow Vole	*Microtus pennsylvanicus*	25
7 species	Masked Shrew	*Sorex cinereus*	8
	Meadow Jumping Mouse	*Zapus hudsonicus*	3
	Short-tailed Shrew	*Blarina brevicauda*	2
	White-tailed Deer	*Odocoileus virginianus*	1
	Deer Mouse	*Peromyscus maniculatus*	1
	Western Harvest Mouse	*Reithrodontomys megalotis*	1

Jarvis

52 vertebrate species

			entries
Amphibians	Western Chorus Frog	*Pseudacris triseriata*	5
6 species	Bullfrog	*Rana catesbeiana*	4
	American Toad	*Bufo americanus*	2
	Gray Treefrog	*Hyla versicolor*	2
	Plain's Leopard Frog	*Rana blairi*	2
	Northern Leopard Frog	*Rana pipiens*	1
Reptiles	Northern Water Snake	*Nerodia sipedon*	1
2 species	Eastern Garter Snake	*Thamnophis sirtalis*	1
Birds	Red-winged Blackbird	*Agelaius phoeniceus*	33
36 species	Common Yellowthroat	*Geothlypis trichas*	31
	Song Sparrow	*Melospiza melodia*	28
	Indigo Bunting	*Passerina cyanea*	22
	Dickcissel	*Spiza americana*	19
	Yellow-billed Cuckoo	*Coccyzus americanus*	11
	Northern Oriole	*Icterus galbula*	10
	Northern Cardinal	*Cardinalis cardinalis*	9
	Warbling Vireo	*Vireo gilvus*	7
	American Robin	*Turdus migratorius*	6
	Blue Jay	*Cyanocitta cristata*	5
	Brown-headed Cowbird	*Molothrus ater*	5
	Eastern Meadowlark	*Sturnella magna*	5
	Common Grackle	*Quiscalus quiscula*	4
	White-breasted Nuthatch	*Sitta carolinensis*	4
	House Wren	*Troglodytes aedon*	4
	American Goldfinch	*Carduelis tristis*	3
	Red-headed Woodpecker	*Melanerpes erythrocephalus*	3
	Black-capped Chickadee	*Parus altricapillus*	3
	Eastern Wood Pewee	*Contupus tristis*	2
	Great-crested Flycatcher	*Myiarchus crinitus*	2
	Cliff Swallow	*Petrochelidon fulva*	2
	Ring-necked Pheasant	*Phasianus colchicus*	2
	Carolina Wren	*Thryothorus ludovicianus*	2
	Brown Thrasher	*Toxostoma rufum*	2
	Eastern Kingbird	*Tyrannus tyrannus*	2
	Mourning Dove	*Zenaida macroura*	2
	Red-tailed Hawk	*Buteo jamaicensis*	1

	American Crow	*Corvus brachyrhynchos*	1
	Gray Catbird	*Dumetella carolinensis*	1
	Barn Swallow	*Hirundo rustica*	1
	Wood Thrush	*Hylocichla mustelina*	1
	Yellow-breasted Chat	*Icteria virens*	1
	Tufted Titmouse	*Parus bicolor*	1
	House Sparrow	*Passer domesticus*	1
	Blue-gray Gnatcatcher	*Polioptila caeulea*	1
Mammals	Deer/White-footed Mouse	*Peromyscus* spp.	16
8 species	Western Harvest Mouse	*Reithrodontomys megalotis*	10
	Meadow Vole	*Microtus pennsylvanicus*	8
	Short-tailed Shrew	*Blarina brevicauda*	4
	Prairie Vole	*Microtus ochrogaster*	4
	White-tailed Deer	*Odocoileus virginianus*	2
	Masked Shrew	*Sorex cinereus*	2
	Eastern Cottontail	*Sylvilagus floridanus*	1

Palisades

49 vertebrate species			entries
Amphibians	Bullfrog	*Rana catesbeiana*	5
6 species	Cricket Frog	*Acris crepitans*	2
	American Toad	*Bufo americanus*	2
	Western Chorus Frog	*Pseudacris triseriata*	2
	Northern Leopard Frog	*Rana pipiens*	2
	Green Frog	*Rana clamitans*	1
Reptiles	Brown Snake	*Storeria dekayi*	1
2 species	Eastern Garter Snake	*Thamnophis sirtalis*	1
Birds	Red-winged Blackbird	*Agelaius phoeniceus*	31
34 species	Mallard	*Anas platyrhynchos*	12
	Wood Duck	*Aix sponsa*	11
	Song Sparrow	*Melospiza melodia*	11
	Killdeer	*Charadrius vociferus*	10
	American Goldfinch	*Carduelis tristis*	8
	Common Yellowthroat	*Geothlypis trichas*	8
	Barn Swallow	*Hirundo rustica*	6
	Canada Goose	*Branta canadensis*	5
	Eastern Meadowlark	*Sturnella magna*	5
	Common Snipe	*Capella gallinago.*	4
	Ring-necked Duck	*Aythya collaris*	2
	Western Sandpiper	*Calidris mauri*	2
	Least Sandpiper	*Calidris minutilla*	2
	Least Bittern	*Ixobrychus exilis*	2
	Sora	*Porzana carolina*	2
	Virginia Rail	*Rallus limicola*	2
	American Robin	*Turdus migratorius*	2
	Mourning Dove	*Zenaida macroura*	2
	Blue-winged Teal	*Anas discors*	1
	Great Blue Heron	*Ardea herodias*	1
	Redhead	*Aythya americana*	1
	Semi-palmated Sandpiper	*Calidris pusilla*	1
	Great Egret	*Casmerodius albus*	1
	Belted Kingfisher	*Ceryle alcyon*	1
	Chimney Swift	*Chaetura pelagica*	1
	Rock Dove	*Columba livia*	1
	Short-billed Dowitcher	*Limnodromus griseus*	1

	House Sparrow	*Passer domesticus*	1
	Savannah Sparrow	*Passerculus sandwichensis*	1
	Bank Swallow	*Riparia riparia*	1
	Dickcissel	*Spiza americana*	1
	Rough-winged Swallow	*Stelgidopteryx ruficollis*	1
	Tree Swallow	*Tachycineta bicolor*	1
Mammals	Meadow Vole	*Microtus pennsylvanicus*	14
6 species	Deer Mouse	*Peromyscus maniculatus*	13
	Short-tailed Shrew	*Blarina brevicauda*	8
	Masked Shrew	*Sorex cinereus*	7
	White-tailed Deer	*Odocoileus virginianus*	1
	White-footed Mouse	*Peromyscus leucopus*	1

Wickiup Hill

37 vertebrate species			entries
Amphibians	Northern Leopard Frog	*Rana pipiens*	2
2 species	Tiger Salamander	*Ambystoma tigrinum*	1
Reptiles	Brown Snake	*Storeria dekayi*	2
2 species	Snapping Turtle	*Chelydra serpentina*	1
Birds	American Goldfinch	*Carduelis tristis*	3
26 species	Willow Flycatcher	*Empidonax trailii*	3
	Ring-necked Pheasant	*Phasianus colchicus*	3
	Dickcissel	*Spiza americana*	3
	Red-winged Blackbird	*Agelaius phoeniceus*	2
	Northern Cardinal	*Cardinalis cardinalis*	2
	Killdeer	*Charadrius vociferus*	2
	Sedge Wren	*Cistothorus platensis*	2
	Common Yellowthroat	*Geothlypis trichas*	2
	Song Sparrow	*Melospiza melodia*	2
	Brown-headed Cowbird	*Molothrus ater*	2
	Osprey	*Pandion halieatus*	2
	Indigo Bunting	*Passerina cyanea*	2
	Rose-breasted Grosbeak	*Pheucticus ludovicianus*	2
	Wood Duck	*Aix sponsa*	1
	Great Blue Heron	*Ardea herodius*	1
	Gray Catbird	*Dumetella carolinensis*	1
	Baltimore Oriole	*Icterus galbula*	1
	Red-headed Woodpecker	*Melanerpes erythrocephalus*	1
	Downey Woodpecker	*Picoides pubescens*	1
	Common Grackle	*Quiscalus quiscula*	1
	Eastern Bluebird	*Sialia sialius*	1
	Chipping Sparrow	*Spizella passerina*	1
	Tree Swallow	*Tachycineta bicolor*	1
	Lesser Yellowlegs	*Tringa flavipes*	1
	Yellow-throated Vireo	*Vireo flavifrons*	1
Mammals	Prairie Vole	*Microtus ochrogaster*	8
7 species	Deer Mouse	*Peromyscus maniculatus*	5
	Masked Shrew	*Sorex cinereus*	5
	Short-tailed Shrew	*Blarina brevicauda*	4
	Meadow Vole	*Microtus pennsylvanicus*	4
	White-footed Mouse	*Peromyscus leucopus*	2

Boevers

39 vertebrate species			entries
Amphibians	American Toad	*Bufo americanus*	6
5 species	Western Chorus Frog	*Pseudacris triseriata*	4
	Gray Treefrog	*Hyla versicolor*	3
	Bullfrog	*Rana catesbeiana*	3
	Northern Leopard Frog	*Rana pipiens*	2
	American Toad (Tadpole)	*Bufo americanus*	1
Reptiles	Red-sided Garter Snake	*Thamnophis sirtalis parietalis*	1
1 species			
Birds	Red-winged Blackbird	*Agelaius phoeniceus*	18
25 species	Dickcissel	*Spiza americana*	14
	Song Sparrow	*Melospiza melodia*	9
	Common Yellowthroat	*Geothlypis trichas*	7
	American Goldfinch	*Carduelis tristis*	6
	Ring-necked Pheasant	*Phasianus colchicus*	3
	Mourning Dove	*Zenaida macroura*	3
	Spotted Sandpiper	*Actitis macularia*	2
	Grasshopper Sparrow	*Ammodramus savannarum*	2
	Canada Goose	*Branta canadensis*	2
	Killdeer	*Charadrius vociferus*	2
	Marsh Wren	*Cistothorus palustris*	2
	Sedge Wren	*Cistothorus platensis*	2
	Cliff Swallow	*Petrochelidon pyrrhonota*	2
	Indigo Bunting	*Spizella passerina*	2
	Eastern Kingbird	*Tyrannus tyrannus*	2
	Cedar Waxwing	*Bombycilla cedrorum*	1
	Common Snipe	*Capella gallinago*	1
	Northern Cardinal	*Cardinalis cardinalis*	1
	Northern Flicker	*Colaptes auratus*	1
	Bobolink	*Dolichonyx oryzivorous*	1
	Barn Swallow	*Hirundo rustica*	1
	Sora	*Porzana carolina*	1
	Eastern Bluebird	*Sialia sialus*	1
	American Robin	*Turdus migratorius*	1
Mammals	Meadow Vole	*Microtus pennsylvanicus*	6
8 species	Masked Shrew	*Sorex cinereus*	5

House Mouse	*Mus musculus*	3
White-footed Mouse	*Peromyscus leucopus*	3
Western Harvest Mouse	*Reithrodontomys megalotis*	3
Short-tailed Shrew	*Blarina brevicauda*	1
White-tailed Deer	*Odocoileus virginianus*	1
Deer Mouse	*Peromyscus maniculatus*	1

Badger Creek

40 vertebrate species

			entries
Amphibians	American Toad	*Bufo americanus*	3
6 species	Western Chorus Frog	*Pseudacris triseriata*	3
	Bullfrog	*Rana catesbeiana*	3
	Cricket Frog	*Acris crepitans*	2
	Northern Leopard Frog	*Rana pipiens*	2
	Plains Leopard Frog	*Rana blairi*	1
Reptiles	Snapping Turtle	*Chelydra serpentina*	2
7 species	Western Ribbon Snake	*Thamnophis proximus*	2
	Eastern Garter Snake	*Thamnophis sirtalis*	2
	Painted Turtle	*Chrysemys picta*	1
	Racer	*Coluber constrictor*	1
	Plains Garter Snake	*Thamnophis radix*	1
	Red-sided Garter Snake	*Thamnophis sirtalis parietalis*	1
	Fox snake	*Elaphe vulpina*	1
Birds	American Goldfinch	*Carduelis tristis*	18
19 species	Common Yellowthroat	*Geothlypis trichas*	11
	Common Grackle	*Quiscalus quiscula*	9
	Red-winged Blackbird	*Agelaius phoeniceus*	7
	Dickcissel	*Spiza americana*	7
	Killdeer	*Charadrius vociferus*	5
	Eastern Bluebird	*Sialia sialus*	4
	Great Blue Heron	*Ardea herodius*	2
	Northern Flicker	*Colaptes auratus*	2
	American Crow	*Corvus brachyrhynchos*	2
	Hooded Merganser	*Lophodytes cucullatus*	2
	Indigo Bunting	*Spizella passerina*	2
	Wood Duck	*Aix sponsa*	1
	Blue-winged Teal	*Anas discors*	1
	Wild Turkey	*Meleagris gallopavo*	1
	Song Sparrow	*Melospiza melodia*	1
	Eastern Meadowlark	*Sturnella magna*	1
	Tree Swallow	*Tachycineta bicolor*	1
	Eastern Kingbird	*Tyrannus tyrannus*	1
Mammals	Prairie Vole	*Microtus ochrogaster*	17
8 species	Deer/White-footed Mouse	*Peromyscus* spp.	13
	Western Harvest Mouse	*Reithrodontomys megalotis*	13

Masked Shrew	*Sorex cinereus*	7
Short-tailed Shrew	*Blarina brevicauda*	2
Thirteen-lined Ground Squirrel	*Spermophilus tridecemlineatus*	2
Meadow Vole	*Microtus pennsylvanicus*	1
White-tailed Deer	*Odocoileus virginianus*	1

Mink Creek

66 vertebrate species

			entries
Amphibians	Bullfrog	*Rana catesbeiana*	10
3 species	American Toad	*Bufo americanus*	8
	Northern Leopard Frog	*Rana pipiens*	4
	Bullfrog (metamorph)	*Rana catesbeiana*	2
	Bullfrog (tadpole)	*Rana catesbeiana*	1
	Northern Leopard Frog (metamorph)	*Rana pipiens*	1
Reptiles	Red-sided Garter Snake	*Thamnophis sirtalis parietalis*	1
1 species			
Birds	Red-winged Blackbird	*Agelaius phoeniceus*	11
53 species	Mallard	*Anas platyrhynchos*	11
	Canada Goose	*Branta canadensis*	10
	Killdeer	*Charadrius vociferus*	10
	Dickcissel	*Spiza americana*	8
	American Crow	*Corvus brachyrhynchos*	6
	American Goldfinch	*Carduelis tristis*	5
	Blue-winged Teal	*Anas discors*	4
	Barn Swallow	*Hirundo rustica*	4
	Common Grackle	*Quiscalus quiscula*	4
	Wood Duck	*Aix sponsa*	3
	Northern Shoveler	*Anas clypeata*	3
	Great Blue Heron	*Ardea herodius*	3
	Song Sparrow	*Melospiza melodia*	3
	Ring-necked Pheasant	*Phasianus colchicus*	3
	Pied-billed Grebe	*Podilymbus podiceps*	3
	Grasshopper Sparrow	*Ammodramus savannarum*	2
	American Widgeon	*Anas americana*	2
	Gadwall	*Anas strepera*	2
	Ring-necked Duck	*Aythya collaris*	2
	American Coot	*Fulica americana*	2
	Tree Swallow	*Tachycineta bicolor*	2
	Eastern Kingbird	*Tyrannus tyrannus*	2
	Mourning Dove	*Zenaida macroura*	2
	Northern Pintail	*Anas acuta*	1
	Greater White-fronted Goose	*Anser albifrons*	1
	Lesser Scaup	*Aythya affinis*	1
	Redhead	*Aythya americana*	1

	Cedar Waxwing	*Bombycilla cedrorum*	1
	American Bittern	*Botaurus lentiginosus*	1
	Common Goldeneye	*Bucephala clangula*	1
	Red-tailed Hawk	*Buteo jamaicencis*	1
	Pectoral Sandpiper	*Calidris melanotos*	1
	Least Sandpiper	*Calidris minutilla*	1
	Snow Goose	*Chen caerulescens*	1
	Northern Harrier	*Circus cyaneus*	1
	Marsh Wren	*Cistothorus palustris*	1
	Trumpeter Swan	*Cygnus buccinator*	1
	Common Snipe	*Capella gallinago*	1
	Common Yellowthroat	*Geothlypis trichas*	1
	Long-billed Dowitcher	*Limmodromus scolopaceus*	1
	Common Merganser	*Mergus merganser*	1
	Brown-headed Cowbird	*Molothrus ater*	1
	Ruddy Duck	*Oxyura jamaicencis*	1
	Savannah Sparrow	*Passerculus sandwichensis*	1
	Cliff Swallow	*Petrochelidon pyrrhonota*	1
	Double-breasted Cormorant	*Phalacrocorax*	1
	Rufous-sided Towhee	*Pipilo erythropthalmus*	1
	American Woodcock	*Scolopax minor*	1
	American Tree Sparrow	*Spizella arborea*	1
	European Starling	*Sturnus vulgaris*	1
	Lesser Yellowlegs	*Tringa flavipes*	1
	American Robin	*Turdus migratorius*	1
Mammals	Masked Shrew	*Sorex cinereus*	17
9 species	Meadow Vole	*Microtus pennsylvanicus*	14
	Short-tailed Shrew	*Blarina brevicauda*	10
	Deer Mouse	*Peromyscus maniculatus*	5
	Muskrat	*Ondatra zibethicus*	4
	Meadow Jumping Mouse	*Zapus hudsonicus*	3
	Western Harvest Mouse	*Reithrodontomys megalotis*	2
	Long-tailed Weasel	*Mustela frenata*	1
	Eastern Cottontail Rabbit	*Sylvilagus floridanus*	1

Brush Creek

56 vertebrate species

			entries
Amphibians	Cricket Frog	*Acris crepitans*	6
6 Species	Bullfrog	*Rana catesbeiana*	5
	Gray Treefrog	*Hyla versicolor*	2
	Western Chorus Frog	*Pseudacris triseriata*	2
	American Toad	*Bufo americanus*	1
	Cope's Gray Treefrog	*Hyla chrysoscelis*	1
Reptiles	Painted Turtle	*Chrysemys picta*	5
3 Species	Snapping Turtle	*Chelydra serpentina*	3
	Brown Snake	*Storeria dekayi*	1
	Fox Snake	*Elaphe vulpina*	1
Birds	Red-winged Blackbird	*Agelaius phoeniceus*	14
39 species	American Goldfinch	*Carduelis tristis*	10
	Gray Catbird	*Dumetella carolinensis*	8
	Red-headed Woodpecker	*Melanerpes erythrocephalus*	7
	Tree Swallow	*Tachycineta bicolor*	7
	Northern Cardinal	*Cardinalis cardinalis*	6
	Common Yellowthroat	*Geothlypis trichas*	6
	Baltimore Oriole	*Icterus galbula*	6
	American Robin	*Turdus migratorius*	6
	Indigo Bunting	*Spizella passerina*	5
	Mourning Dove	*Zenaida macroura*	5
	Common Grackle	*Quiscalus quiscula*	4
	Field Sparrow	*Spizella pusilla*	4
	Wood Duck	*Aix sponsa*	3
	Canada Goose	*Branta canadensis*	3
	Northern Shoveler	*Anas clypeata*	2
	Blue-winged Teal	*Anas discors*	2
	Mallard	*Anas platyrhynchos*	2
	Ring-necked Duck	*Aythya collaris*	2
	Scaup	*Aythya sp.*	2
	Cedar Waxwing	*Bombycilla cedrorum*	2
	Belted Kingfisher	*Ceryle alcyon*	2
	Blue Jay	*Cyanocitta cristata*	2
	American Coot	*Fulica americana*	2
	Song Sparrow	*Melospiza melodia*	2

	Brown-headed Cowbird	*Molothrus ater*	2
	Dickcissel	*Spiza americana*	2
	European Starling	*Sturna vulgaris*	2
	Brown Thrasher	*Toxostoma rufum*	2
	Eastern Kingbird	*Tyrannus tyrannus*	2
	American Widgeon	*Anas americana*	1
	Green-winged Teal	*Anas crecca*	1
	American Bittern	*Botaurus lentiginosus*	1
	Killdeer	*Charadrius vociferus*	1
	Sedge Wren	*Cistothorus platensis*	1
	Swamp Sparrow	*Melospiza georgiana*	1
	Eastern Phoebe	*Sayomis phoebe*	1
	American Tree Sparrow	*Spizella arborea*	1
	Warbling Vireo	*Vireo gilvus*	1
Mammals	Deer/White-footed Mouse	*Peromyscus* spp.	15
8 species	Western Harvest Mouse	*Reithrodontomys megalotis*	13
	Masked Shrew	*Sorex cinereus*	13
	Meadow Vole	*Microtus pennsylvanicus*	10
	Short-tailed Shrew	*Blarina brevicauda*	7
	Prairie Vole	*Microtus ochrogaster*	3
	White-tailed Deer	*Odocoileus virginianus*	2
	Meadow Jumping Mouse	*Zapus hudsonius*	2

Dike

59 vertebrate species

			entries
Amphibians	Northern Leopard Frog	*Rana pipiens*	19
6 species	Bullfrog	*Rana catesbeiana*	15
	American Toad	*Bufo americanus*	9
	Western Chorus Frog	*Pseudacris triseriata*	7
	Tiger Salamander	*Ambystoma tigrinum*	2
	Gray Treefrog	*Hyla versicolor*	2
Reptiles	Plains Garter Snake	*Thamnophis radix*	1
1 species			
Birds	Wood Duck	*Aix sponsa*	7
41 species	Killdeer	*Charadrius vociferus*	7
	Red-winged Blackbird	*Agelaius phoeniceus*	6
	Song Sparrow	*Melospiza melodia*	5
	Common Grackle	*Quiscalus quiscula*	5
	Great Blue Heron	*Ardea herodius*	4
	Canada Goose	*Branta canadensis*	4
	Dickcissel	*Spiza americana*	4
	Blue-winged Teal	*Anas discors*	3
	Red-tailed Hawk	*Buteo jamaicencis*	3
	American Goldfinch	*Carduelis tristis*	3
	Grasshopper Sparrow	*Ammodramus savannarum*	2
	Green-winged Teal	*Anas crecca*	2
	Mallard	*Anas platyrhynchos*	2
	Gadwall	*Anas strepera*	2
	Belted Kingfisher	*Ceryle alcyon*	2
	Bobolink	*Dolichonyx oryzivorous*	2
	American Coot	*Fulica americana*	2
	Common Yellowthroat	*Geothlypis trichas*	2
	Barn Swallow	*Hirundo rustica*	2
	Cliff Swallow	*Petrochelidon pyrrhonota*	2
	Sora	*Porzana carolina*	2
	European Starling	*Sturnus vulgaris*	2
	Tree Swallow	*Tachycineta bicolor*	2
	American Widgeon	*Anas americana*	1
	Northern Shoveler	*Anas clypeata*	1
	Green Heron	*Butorides virescens*	1
	Northern Harrier	*Circus cyaneus*	1
	Marsh Wren	*Cistothorus palustris*	1

	Sedge Wren	*Cistothorus platensis*	1
	Northern Flicker	*Colaptes auratus*	1
	Trumpeter Swan	*Cygnus buccinator*	1
	Black-crowned Night Heron	*Nycticorax nycticorax*	1
	Ring-necked Pheasant	*Phasianus colchicus*	1
	Rufous-sided Towhee	*Pipilo erythropthalmus*	1
	Horned Grebe	*Podiceps auritus*	1
	Pied-billed Grebe	*Podilymbus podiceps*	1
	Field Sparrow	*Spizella pusilla*	1
	Eastern Kingbird	*Tyrannus tyrannus*	1
	Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	1
	Mourning Dove	*Zenaida macroura*	1
Mammals	Masked Shrew	*Sorex cinereus*	19
11 species	Meadow Vole	*Microtus pennsylvanicus*	16
	Western Harvest Mouse	*Reithrodontomys megalotis*	12
	Deer Mouse	*Peromyscus maniculatus*	8
	Short-tailed Shrew	*Blarina brevicauda*	6
	13-lined Ground Squirrel	*Spermophilus tridecemlineatus*	3
	White-footed Mouse	*Peromyscus leucopus*	2
	Long-tailed Weasel	*Mustela frenata*	1
	White-tailed Deer	*Odocoileus virginianus*	1
	Eastern Cottontail Rabbit	*Sylvilagus floridanus*	1
	Red Fox	*Vulpes vulpes*	1

Engeldinger Marsh

45 vertebrate species

			entries
Amphibians	Tiger Salamander	*Ambystoma tigrinum*	7
8 species	Northern Leopard Frog	*Rana pipiens*	6
	Cricket Frog	*Acris crepitans*	4
	Western Chorus Frog	*Pseudacris triseriata*	4
	Bullfrog	*Rana catesbeiana*	4
	American Toad	*Bufo americanus*	2
	Cope's Gray Treefrog	*Hyla chrysoscelis*	2
	Plains Leopard Frog	*Rana blairi*	1
Reptiles	Eastern Garter Snake	*Thamnophis sirtalis*	3
1 species			
Birds	Red-winged Blackbird	*Agelaius phoeniceus*	20
28 species	Song Sparrow	*Melospiza melodia*	15
	Common Yellowthroat	*Geothlypis trichas*	13
	American Goldfinch	*Carduelis tristis*	8
	Marsh Wren	*Cistothorus palustris*	5
	Common Grackle	*Quiscalus quiscula*	5
	Eastern Meadowlark	*Sturnella magna*	4
	Tree Swallow	*Tachycineta bicolor*	4
	Grasshopper Sparrow	*Ammodramus savannarum*	3
	Barn Swallow	*Hirundo rustica*	3
	Eastern Kingbird	*Tyrannus tyrannus*	3
	Wood Duck	*Aix sponsa*	2
	Cedar Waxwing	*Bombycilla cedrorum*	2
	Bobolink	*Dolichonyx oryzivorous*	2
	Hooded Merganser	*Lophodytes cucullatus*	2
	Mourning Dove	*Zenaida macroura*	2
	Northern Shoveler	*Anas clypeata*	1
	Blue-winged Teal	*Anas discors*	1
	Mallard	*Anas platyrhynchos*	1
	Canada Goose	*Branta canadensis*	1
	Killdeer	*Charadrius vociferus*	1
	Northern Harrier	*Circus cyaneus*	1
	Sedge Wren	*Cistothorus platensis*	1
	Northern Flicker	*Colaptes auratus*	1
	Swamp Sparrow	*Melospiza georgiana*	1
	Northern Mockingbird	*Mimus polyglottos*	1

	Pied-billed Grebe	*Podilymbus podiceps*	1
	American Robin	*Turdus migratorius*	1
Mammals	Meadow Vole	*Microtus pennsylvanicus*	14
9 Species	Masked Shrew	*Sorex cinereus*	11
	Short-tailed Shrew	*Blarina brevicauda*	10
	Deer/White-footed Mouse	*Peromyscus spp.*	9
	Western Harvest Mouse	*Reithrodontomys megalotis*	5
	Prairie Vole	*Microtus ochrogaster*	3
	Least Weasel	*Mustela nivalis*	1
	Mink	*Mustela vison*	1
	Eastern Cottontail Rabbit	*Sylvilagus floridanus*	1

Hay-Buhr

92 vertebrate species

			entries
Amphibians	Northern Leopard Frog	*Rana pipiens*	6
5 species	Western Chorus Frog	*Pseudacris triseriata*	3
	Bullfrog	*Rana catesbeiana*	3
	American Toad	*Bufo americanus*	2
	Gray Treefrog	*Hyla versicolor*	2
Reptiles	Painted Turtle	*Chrysemys picta*	3
9 species	Plains Garter Snake	*Thamnophis radix*	2
	Blanding's Turtle	*Emydoidea blandingii*	1
	Graham's Crawfish Snake	*Nerodia grahami*	1
	Northern Water Snake	*Nerodia sipedon*	1
	Smooth Green Snake	*Opheodrys vernalis*	1
	Eastern Massasauga Rattlesnake	*Sistrurus catenatus*	1
	Northern Redbelly Snake	*Storeria occipitomaculata*	1
	Western Ribbon Snake	*Thamnophis proximus*	1
Birds	Red-winged Blackbird	*Agelaius phoeniceus*	43
70 species	Common Yellowthroat	*Geothlypis trichas*	32
	American Goldfinch	*Carduelis tristis*	27
	Yellow Warbler	*Dendroica petechia*	18
	Sedge Wren	*Cistothorus platensis*	16
	Swamp Sparrow	*Melospiza georgiana*	15
	Cliff Swallow	*Petrochelidon pyrrhonota*	14
	American Robin	*Turdus migratorius*	14
	Warbling Vireo	*Vireo gilvus*	13
	Northern Cardinal	*Cardinalis cardinalis*	11
	Killdeer	*Charadrius vociferus*	11
	Song Sparrow	*Melospiza melodia*	11
	House Wren	*Troglodytes aedon*	11
	Marsh Wren	*Cistothorus palustris*	9
	Yellow-billed Cuckoo	*Coccyzus americanus*	9
	Gray Catbird	*Dumetella carolinensis*	9
	Brown Thrasher	*Toxostoma rufum*	8
	Mourning Dove	*Zenaida macroura*	8
	Canada Goose	*Branta canadensis*	7
	Common Grackle	*Quiscalus quiscula*	7
	Cedar Waxwing	*Bombycilla cedrorum*	6
	Eastern Meadowlark	*Sturnella magna*	6

Indigo Bunting	*Passerina cyanea*	5
Wood Duck	*Aix sponsa*	5
Great Blue Heron	*Ardea herodias*	5
Barn Swallow	*Hirundo rustica*	5
Brown-headed Cowbird	*Molothrus ater*	5
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	5
Mallard	*Anas platyrhynchos*	4
Northern Harrier	*Circus cyaneus*	3
Sandhill Crane	*Grus canadensis*	3
Black-capped Chickadee	*Parus atricapillus*	3
Ring-necked Pheasant	*Phasianus colchicus*	3
American Redstart	*Setophaga ruticilla*	3
Eastern Bluebird	*Sialia sialius*	3
Dickcissel	*Spiza americana*	3
American Tree Sparrow	*Spizella arborea*	3
Chipping Sparrow	*Spizella passerina*	3
Tree Swallow	*Tachycineta bicolor*	3
Grasshopper Sparrow	*Ammodramus savannarum*	2
Northern Shoveler	*Anas clypeata*	2
Green-winged Teal	*Anas crecca*	2
Blue-winged Teal	*Anas discors*	2
Ring-necked Duck	*Aythya collaris*	2
Red-tailed Hawk	*Buteo jamaicencis*	2
Belted Kingfisher	*Ceryle alcyon*	2
Eastern Wood Peewee	*Contupus virens*	2
American Crow	*Corvus brachyrhynchos*	2
Bobolink	*Dolichonyx oryzivorus*	2
Least Flycatcher	*Empindonax minimus*	2
American Coot	*Fulica americana*	2
House Sparrow	*Passer domesticus*	2
Pied-billed Grebe	*Podilymbus podiceps*	2
Sora	*Porzana carolina*	2
Eastern Kingbird	*Tyrannus tyrannus*	2
American Widgeon	*Anas americana*	1
Bufflehead	*Bucephala albeola*	1
Red-shouldered Hawk	*Buteo lineatus*	1
Common Snipe	*Capella gallinago*	1
Turkey Vulture	*Cathartes aurua*	1
Swainson's Thrush	*Catharus ustulatus*	1
Black-billed Cuckoo	*Coccyzus erythropthalmus*	1
Blue Jay	*Cyanocitta cristata*	1
Northern Oriole	*Icterus galbula*	1

	Hooded Merganser	*Lophodytes cucullatus*	1
	Great Crested Flycatcher	*Myiarchus crinitus*	1
	Ruddy Duck	*Oxyura jamaicencis*	1
	Downey Woodpecker	*Picoides pubescens*	1
	White-breasted Nuthatch	*Sitta carolinensis*	1
	Common Tern	*Sterna hirundo*	1
Mammals	White-tailed Deer	*Odocoileus virginianus*	4
8 species	Western Harvest Mouse	*Reithrodontomys megalotis*	2
	Plains Pocket Gopher	*Geomys bursarius*	1
	Prairie Vole	*Microtus ochrogaster*	1
	Meadow Vole	*Microtus pennsylvanicus*	1
	Mink	*Mustela vison*	1
	White-footed Mouse	*Peromyscus leucopus*	1
	Deer Mouse	*Peromyscus maniculatus*	1

Doolittle Prairie

25 vertebrate species			entries
Amphibians	Northern Leopard Frog	*Rana pipiens*	2
2 species	Western Chorus Frog	*Pseudacris triseriata*	1
Reptiles	Plains Garter Snake	*Thamnophis radix*	3
2 species	Eastern Garter Snake	*Thamnophis sirtalis*	1
Birds	Red-winged Blackbird	*Agelaius phoeniceus*	28
15 species	Common Yellowthroat	*Geothlypis trichas*	15
	Dickcissel	*Spiza americana*	12
	Song Sparrow	*Melospiza melodia*	11
	Bobolink	*Dolichonyx oryzivorous*	6
	Sedge Wren	*Cistothorus platensis*	5
	Eastern Meadowlark	*Sturnella magna*	4
	Western Meadowlark	*Sturnella neglecta*	3
	Killdeer	*Charadrius vociferus*	2
	Gray Catbird	*Dumetella carolinensis*	1
	Willow Flycatcher	*Empidonax trailii*	1
	Ring-necked Pheasant	*Phasianus colchicus*	1
	Common Grackle	*Quiscalus quiscula*	1
	Indigo Bunting	*Spizella passerina*	1
	Eastern Kingbird	*Tyrannus tyrannus*	1
Mammals	Western Harvest Mouse	*Reithrodontomys megalotis*	16
6 species	Short-tailed Shrew	*Blarina brevicauda*	13
	Deer/White-footed Mouse	*Peromyscus spp.*	11
	Masked Shrew	*Sorex cinereus*	9
	Meadow Vole	*Microtus pennsylvanicus*	5
	Meadow Jumping Mouse	*Zapus hudsonius*	1

Appendix 2. Voucher specimens.

JRP#		Family	Species	date	notes	locality
1510	Reptilia	Colubridae	*Thamnophis proximus*	31-May-06	active in grass by drift fence, male	Iowa:Warren Co:Badger Creek mitigation site
1511	Reptilia	Colubridae	*Thamnophis radix*	9-Jun-06	active in grass, male	Iowa:Story Co:Doolittle Prairie
1512	Amphibia	Bufonidae	*Bufo americanus*	8-Jun-06	5 metamorphs	Iowa:Warren Co:Badger Creek mitigation site
1513	Amphibia	Ranidae	*Rana catesbeiana*	9-Jun-06	late tadpole in minnow trap	Iowa:Warren Co:Badger Creek mitigation site
1516	Reptilia	Colubridae	*Elaphe vulpina*	27-Jun-06	in drift fence bucket, died in captivity	Iowa:Warren Co:Badger Creek mitigation site
1517	Reptilia	Colubridae	*Thamnophis sirtalis*	26-Jun-06	preg. Female, in grass in open, 28 young released	Iowa:Warren Co:Badger Creek mitigation site
1540	Amphibia	Hylidae	*Acris crepitans*	9-Jun-07	nice green pattern	Iowa:Polk Co:South Point mitigation site
1563	Amphibia	Ranidae	*Rana blairi*	21-Jun-07	recent metamorph	Iowa:Warren Co:Badger Creek wetland (Blue Flag Marsh)
1573	Reptilia	Colubridae	*Thamnophis proximus*	6-Aug-07	preserved 3 young born in captivity	Iowa:Warren Co:Badger Creek wetland (Blue Flag Marsh)
1574	Reptilia	Colubridae	*Thamnophis proximus*	6-Aug-07	preserved 3 young born in captivity	Iowa:Warren Co:Badger Creek wetland (Blue Flag Marsh)
1575	Reptilia	Colubridae	*Thamnophis proximus*	6-Aug-07	preserved 3 young born in captivity	Iowa:Warren Co:Badger Creek wetland (Blue Flag Marsh)
1577	Reptilia	Colubridae	*Thamnophis proximus*	21-Jun-07	Gave birth to 17 young in lab 19 July;preserved 6 Oct 2007	Iowa:Warren Co:Badger Creek wetland (Blue Flag Marsh)
3002	Reptilia	Emydidae	*Chrysemys picta*	9-Jun-07	Shell found by wetland	Iowa:Polk Co:South Point mitigation site

Appendix F

A Comparison of Water Quality in Eastern Iowa Reference and Mitigation Wetlands

A COMPARISON OF WATER QUALITY IN EASTERN IOWA REFERENCE AND MITIGATION WETLANDS

June 2007

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A COMPARISON OF WATER QUALITY IN EASTERN IOWA REFERENCE AND MITIGATION WETLANDS

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Abstract: A set of reference and mitigation wetlands in eastern Iowa were sampled over the summers of 2005 and 2006. Common water quality parameters, with a particular emphasis on nitrogen and phosphorus, were measured to compare the function of the constructed wetlands to the reference sites. In general, few significant differences were observed between the two sets of wetlands.

Key words: wetland, mitigation, water quality, nitrate

INTRODUCTION

To achieve the national goal of "no net loss" of wetlands, the Corps of Engineers or a state agency designated by the U.S. Environmental Protection Agency may impose conditions on projects which impact existing wetlands. If the project entails unavoidable damages to wetlands, then the permittee may be required to provide "compensatory mitigation". This refers to restoration, creation, or enhancement of other wetlands as compensation for damages to natural wetlands(Committee on Mitigating Wetland Losses 2001). While the Corps has kept data on the area of constructed wetlands required for compensatory mitigation, there has been little data available as to whether these constructed wetlands were successful in terms of ecological functions (GAO, 2001). In recent years, considerable effort has been directed toward developing consistent tools capable of assessing the complex functions of wetlands (Fennessy *et al.* 2004).

One piece of the assessment strategy is an examination of the water quality of the mitigation wetlands. Measurement of key water quality parameters may provide quick, quantitative information about the functioning of the wetland. A key area of interest in both natural and mitigation wetlands is the utilization of nutrients – particularly in primarily agricultural watersheds (Richardson 1989). While the wetlands studied in this work are not optimized for nutrient removal, it is of interest to assess their ability to remove nitrogen and phosphorus from surface and shallow groundwater that enters their watershed. Constructed wetlands may play a significant role in reducing nitrogen and phosphorus loading to Iowa's surface waters by intercepting overland and shallow groundwater flows and creating conditions favorable for denitrification and for phosphorus precipitation (Jordan 2003).

METHODS

Sample Site Selection

The selection of sites within the designated wetlands was patterned after that of Lougheed. The wetland was inspected to determine if there was an obvious inflow and

outflow. If so, grab samples were collected near these points (See Figures 2a-2o in the overall report). If not, samples were obtained from a near shore location in open water.

Site Descriptions

New Hampton (site 4, sampled in 2005) – the New Hampton site had one outflow (4SO) on the south which was sampled directly from the culvert. There were three inflows; the one on the northwest side was the largest (4NWI), followed by a stream on the southeast side (4SEI) and a small stream on the northeast end (4NEI).

Buhr (site 14, sampled in 2005) – this reference site had one outlet (14O), which passed under a path on the southeast side of the wetland. The inlet (14I) was a shallow stream which passed through the trees on the northwest side of the wetland.

Palisades (site 6, sampled in 2005) – water flowing into this wetland (6I) came from a drainage tile located on the northwest corner of the western wetland at this site. No incoming water was visible on 7/28/2005. A grab sample (6O) was taken at the south side of this wetland near where overflow would leave the wetland; however, overflow was never observed.

Pleasantville (site 3, sampled in 2005) – grab sample.

South Point (site 2, sampled in 2005) – inlet site (2I) coming out of woods near northwest end of wetland, often with little or no apparent flow. Outlet at south end of wetland (2O) spilling over into waterway.

Engeldinger (site 13, sampled in 2005) – grab sample. Site initally misidentified; 13A was a small isolated wetland located less than ¼ mile from correct site (13B).

Grooms (site 1) and Jarvis (site 5) were dry during the 2005 sampling season.

Wickiup Hill (site 7, sampled in 2006) – grab sample. The wetland became too shallow to sample by 6/29/2006.

Dike (site 12, sampled in 2006) – inlet (12I) from ditch tile and grassed waterway through corn field. Outlet (12O) was culvert at opposite end of the wetland.

Mink (site 10, sampled in 2006) – Grab sample obtained at west end (10W) of wetland near large gully. Sample from outlet (10E) obtained in east end stream (minimal flow).

Boevers (site 8, sampled in 2006) – grab sample from shallow wetland. Site was too shallow to sample by 5/30/2006.

Doolittle (site 15, sampled in 2006) – no standing water in transect, so grab sample was taken from pothole nearest parking area. This site was dry by 6/8/2006.

Brush (site 11, sampled in 2006) – initial samples were from channel leading into wetland (11I) and from concrete spillway (11O). Additional samples came from stream as it entered the site boundary on the north side of the highway (11S) and directly from the culvert on the south side of the highway (11C). This site had extraordinarily high conductivity and high chloride readings, as well as low dissolved oxygen. The stream feeding the wetland receives the effluent from the sewage treatment plant at Monroe, Iowa.

Badger (site 9, sampled in 2006) – grab sample in center of southwest open water. Site was dry by 7/6/2006.

Field Methods

Samples were collected just below the surface of the water directly into sample bottles. All bottles were field-rinsed with sample twice before collection. 50 mL of sample was filtered in the field through a 0.45 μm filter for DRP analysis. All samples for laboratory analysis were immediately stored in a cooler with ice packs until they were transferred to a refrigerator at 4°C. Samples were analyzed the day after collection.

A YSI Model 556 Multiprobe System was used to measure dissolved oxygen, temperature, pH, and conductivity in the field. The instrument was calibrated according to manufacturer's instructions each day prior to measurements. A Hach 2100P Turbidimeter was used for turbidity measurements. Calibration was checked each day with Hach Gelex secondary standards. All field equipment exposed was rinsed three times with deionized water after sampling.

Lab Methods

Ion chromatography (Hautman and Munch, 1997) was utilized to measure chloride, nitrite, nitrate, and sulfate concentrations. Spectroscopic methods were used to measure ammonia (Hach 2004a) and dissolved reactive phosphorus (Hach 2004b). Total phosphorus (Hach 2004c) and total nitrogen (Hach 2004d) were measured using a persulfate digestion prior to colorimetric analysis. Dissolved organic carbon was initially assessed using a manganese COD digestion with spectroscopic measurement (Hach 2004e); later measurements used a more sensitive chromium based technique (Hach 2004f).

Spectroscopic analyses are carried out on Perkin Elmer EZ150 spectrophotometers and ion chromatographic analyses are carried out on a Dionex DX-80. All chromatographic and spectroscopic analyses utilized a minimum of four standards prepared by dilution of a purchased stock solutions (Hach stock solutions for the spectroscopic analyses; Dionex seven-anion standard for the ion chromatographic analysis). Any other reagents used were of reagent grade or higher.

RESULTS

The primary purpose of this study was to compare the water quality of natural wetlands and mitigation wetlands. For this purpose, Hay-Buhr, Engeldinger, and Doolittle were designated as reference sites, and the rest were considered to be mitigation sites. (The Brush Creek mitigation site was excluded from these analyses due to the unusual water chemistry from the sewage treatment plant.) Samples obtained over the course of the study by grab sampling or from the outlet of the wetlands were used to compare the overall water quality of the wetlands. For each parameter measured, t-tests were conducted to determine whether or not statistically significant differences existed between the two groups. As shown in Table 1, a comparison of the means of the parameters examined shows a number of differences between reference wetlands and the mitigation wetlands. Higher pH and lower conductivity are consistent with increased photosynthesis in the mitigation wetlands. That hypothesis could also explain the finding of higher turbidity and total suspended solids in the mitigation wetlands. Higher levels of

ammonia may also result from breakdown of more abundant plant biomass in the mitigation wetlands. While these observations are consistent with increased plant life in the mitigation wetlands, confirmation of the hypothesis will depend on assessment of the vegetation in the wetlands. The hydrology of the individual sites selected have a significant influence on the water chemistry observed, and a more detailed study of the sites would be necessary to definitively assess the sources of the observed differences.

Equally important are the lack of statistically significant difference in nutrient levels. Given the importance of nitrate as a pollutant in eastern Iowa, it is interesting to note the very similar concentrations of NO_3^- in both types of wetlands.

For purposes of understanding the water quality of the wetlands, it is useful to divide them into isolated wetlands (not connected to other surface waters) and connected wetlands (those with surface water inlets and outlets). Isolated wetlands, during the period of observation, primarily rely on precipitation, runoff , and evapotranspiration as their means of exchange with their surroundings (though groundwater inputs and seepage cannot be excluded). Wetlands with surface water inputs and outflows are affected by a significantly larger watershed, and study of those inflows and outflows can reveal a great deal about the processing going on in the wetland.

The wetlands selected for this study can be classified into these categories (see Table 2), though the distinctions are somewhat arbitrary. In particular, the Palisades wetland has surface flow from a field tile, but typically had no outflow. Mink Creek seems to receive surface inflow from its immediate surroundings, with outflow to a local creek. Since the composition of the Palisades wetland will be affected by a larger watershed, it will be classified as connected. Mink's content is primarily determined by its immediate surroundings, so it will listed as isolated.

Using these classifications is particularly instructive with respect to nutrient concentrations in these wetlands, as shown in Table 3. In all cases, the watersheds of the connected wetlands are primarily agricultural. As a result, the larger the watershed, the more likely it is that the wetland will contain elevated levels of nutrients. Again, inflow concentrations are more a reflection of the surrounding watershed than the wetland; Table 3 shows only outflows and grab samples, which are more indicative of the processes in the wetland itself. Higher DO, higher pH, lower conductivity, and higher turbidity in the isolated wetlands are all consistent with higher algal populations in the isolated wetlands – with minimal flow. Higher total phosphorus and COD measurements also were also observed to be coincident with higher algal levels. On the other hand, higher total N and nitrate values found in the connected wetlands likely result from high inputs from surrounding agricultural watersheds. The total N measurements are primarily nitrate. Chloride levels are much higher in the connected wetlands; this may be an indicator of human influence in the inputs to the connected wetlands.

Finally, it is of interest to examine the efficacy of nutrient removal by the wetlands studied. Removal of nitrate is of particular interest, since Iowa rivers have among the highest levels of this nutrient in the nation (Goolsby *et al*. 1999) and wetlands are often touted as potential treatment options. As seen in Figure 1, the efficiency of nitrate removal varied considerably by site and by date. Each of these sites featured one or more inflows of water and a well-defined outlet. Nitrate removal is generally believed to be dependent on

the concentration of nitrate in the inflow and the hydraulic retention time (Toet *et al.* 2005). Of the wetlands studied, Dike was most effective at nitrate removal. The wetland received runoff directly from a waterway draining a cornfield with consistently high concentrations of nitrate. The wetland was relatively large, and drained into a culvert opposite the inflow. This configuration resulted in removal of over 50% of the nitrate concentration during some parts of the summer.

DISCUSSION

In general, the wetlands studied exhibited values for the parameters analyzed which are typical of midwestern surface waters. Compared to all monitoring (streams, lakes, and wetlands) carried out by the Iowa Geological Survey Bureau from 2000-2006 (IGSB 2007a), ammonia, dissolved reactive phosphorus, and total phosphorus averages in this study were at the 75^{th} percentile or above. Chloride, nitrate, total suspended solids, and turbidity averages were in the 25^{th} to 50^{th} percentile of this data set,and the sulfate mean was around the 10^{th} percentile for this time period. Results were also consistent with a study of Iowa wetlands being carried out by the Iowa Geological Survey Bureau during the same time period (IGSB 2006, IGSB 2007b). They sampled 60 sites in the Upper Des Moines lobe and Winnebago River watershed during 2005. 32 of these sites were resampled in 2006 in addition to 40 new sites in north-central Iowa. Water samples were obtained from open water in a canoe by grab sampling. In 2005, nitrate+nitrite concentrations ranged from 0.05 to 27 mg NO_3^--N/L with a mean of 6.2, total phosphorus ranged from 0.05 to 1.2 mg/L with a mean of 0.27, and dissolved reactive phosphorus (or orthophosphate) ranged from 0.02 to 0.72 mg/L with a mean of 0.16. In 2006, the nitrate range was 0.05 to 9 mg NO_3^--N/L (mean 3.55), the total phosphorus range was 0.05 to 3.1 mg/L (mean 0.38 mg/L), and the dissolved reactive phosphorus range was 0.02 to 0.94 mg/L (mean 0.11 mg/L). The results reported in this paper and the IGSB study both illustrate the spatial and temporal variability found in water quality in wetlands. Nutrient inputs to the wetlands from other surface water sources will vary a great deal over the course of a year in these agricultural watersheds. Other research has indicated that spatial variability with wetlands is particularly important for measurements of both dissolved reactive and total phosphorus (Detenbeck *et al.* 1996). Chloride values may also be indicative of a trend toward salinization of surface waters by road salt reported in the northeastern part of the U.S. (Kaushal *et al.* 2005). Two of the wetlands with relatively high chloride levels (Dike and New Hampton) are located near four-lane highways; however, another (Hay-Buhr) is located in a relatively isolated area with respect to roadways.

The comparison of the water quality in reference and mitigation wetlands in Iowa is complicated by the paucity of “natural” wetlands in the state. Ideally, pairing a reference and mitigation wetland with similar hydrology and geology would allow a more detailed analysis of the effectiveness of the mitigation wetlands with respect to water quality. However, the data set that was gathered in this study allows some comparisons to be made. As mentioned above, the differences that were found to be statistically significant were consistent with higher levels of photosynthetic activity in the reference wetlands. In turn, this could be explained by their hydrology, which was either isolated (Engeldinger and Doolittle) or with relatively low flow (Hay-Buhr). A similar study

examining mitigation wetlands in Ohio also found few differences between reference and mitigation wetlands with respect to water quality (Fennessy *et al*. 2004). In comparing 5 reference sites (11 total samples) to 10 mitigation sites (21 samples), the Ohio EPA found significant differences only for pH ($p = 0.05$) and K ($p = 0.024$). While intensive studies of paired wetlands might reveal more subtle differences in water quality, it seems safe to say that occasional grab sampling is unlikely to reveal differences between mitigation and natural wetland sites. (Interestingly, the Ohio EPA study did show significant differences in soil chemistry and physical properties between the two sets of study sites.)

As one might expect, isolated wetlands, which rely primarily on rainwater or groundwater as inputs rather than surface waters from a larger watershed, have significantly different water quality values than those with connections to other surface waters. A study of California vernal pools (Keeley and Zedler 1998) indicates that these isolated wetlands typically have lower nutrient levels, and are also subject to larger diurnal changes in pH. As seen above in Table 3, nitrate levels are much lower in the isolated wetlands in this study. Furthermore, the standard deviation of the pH values recorded in the connected wetlands is about 60% that of the isolated wetlands, indicating considerably more variation in the isolated wetlands. These variations can have ecological effects, selecting for species tolerant of a broader range of conditions.

While mitigation wetlands are not designed with nutrient retention as a primary focus, their ability to remove or transform nutrients from surface waters is an important ecosystem benefit . Research on wetlands constructed for sewage treatment and stormwater retention consistently indicate that the key variable for effective nutrient removal is hydraulic retention time – the longer water with nutrients can be in contact with the substrate, the more effective nutrient removal will be (Toet *et al.* 2005; Carleton *et al.* 2001). However, it is often difficult to characterize flow patterns in a natural wetland, and, unlike a sewage treatment plant, inflows into the wetlands characterized in this study vary widely in volume over time. High flow events may overwhelm the capacity of a wetland to assimilate nutrients. In this study, wetlands with well defined in- and out-flows exhibited a variety of nitrogen retention behaviors. Although flows were not measured, the Dike wetland exhibited higher % nitrate removal at lower flow (longer retention time) conditions which prevailed later in the summer. The New Hampton wetland also was relatively effective at nitrate removal, though the hydrology was more complex due to two small additional inflows not shown on the plot in Figure 1. South Point, with low concentrations of nitrate in the inflow, had a low percentage removal. Hay-Buhr typically had a relatively low surface inflow, but percent removal of nitrate was somewhat erratic. There are numerous possible explanations for this observation; shallow groundwater flow from the surrounding agricultural areas could result in a more constant nitrate concentration in this wetland.

CONCLUSIONS AND RECOMMENDATIONS

Water quality measurements of the type carried out in this study showed few significant differences between reference and mitigation wetlands. While this may be taken as an indication that mitigation wetlands are performing as well as the natural wetlands in achieving water quality goals, more detailed studies with higher spatial and

temporal resolution of paired reference and constructed wetlands (with similar hydrology and geology) would give a clearer comparison.

Hydrology and the geographical setting of the wetlands are more likely to result in difference in water quality than the origin (natural vs. constructed) of the wetland. As with any surface water, water quality is a result of the water sources which create the wetland, stream, or lake. In this case, wetlands fed by surface water flows show the impact of human activity more dramatically than do the isolated wetlands.

In a highly agricultural state such as Iowa, the role of wetlands in retaining excess nutrients from local watersheds is an important benefit. If this is a function that policy-makers deem important, constructed wetlands can be designed to maximize nutrient removal.

Wetlands are remarkably heterogeneous natural systems in both space and time. Occasional sampling and analysis of water quality parameters can give scientists and managers a snapshot of wetland function which is of use in assessing the performance of a given site. More intensive analysis through real-time *in-situ* monitoring or by using more integrative techniques could yield considerably more insights into these important features of the landscape.

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Table 1. Reference vs. mitigation wetlands – grab samples and outflows only

Analyte	Mean (mitigation)	Mean (reference)	Significantly different?	P
DO	9.10	10.74	No	0.349
pH	8.17	7.73	Yes	0.038
Conductivity	313	393	Yes	0.037
Turbidity	20.7	8.6	Yes	0.044
TSS	33.1	8.2	Yes	0.034
NH_3	0.18	0.08	Yes	0.031
DRP	0.19	0.45	No	0.222
Total P	0.89	1.13	No	0.556
Total N	3.70	4.75	No	0.432
NO_3^-N	2.08	2.36	No	0.778
SO_4^{2-}	14.6	16.7	No	0.517
Cl^-	14.6	19.1	No	0.122
COD	45.5	66.6	No	0.285

Table 2. Isolated and connected wetlands

Isolated	Connected
Engeldinger	*Hay-Buhr*
Pleasantville	South Point
Wickiup Hill	New Hampton
Boevers	Brush
Badger	Dike
Doolittle	Palisades
Mink	
(Jarvis)	
(Grooms)	

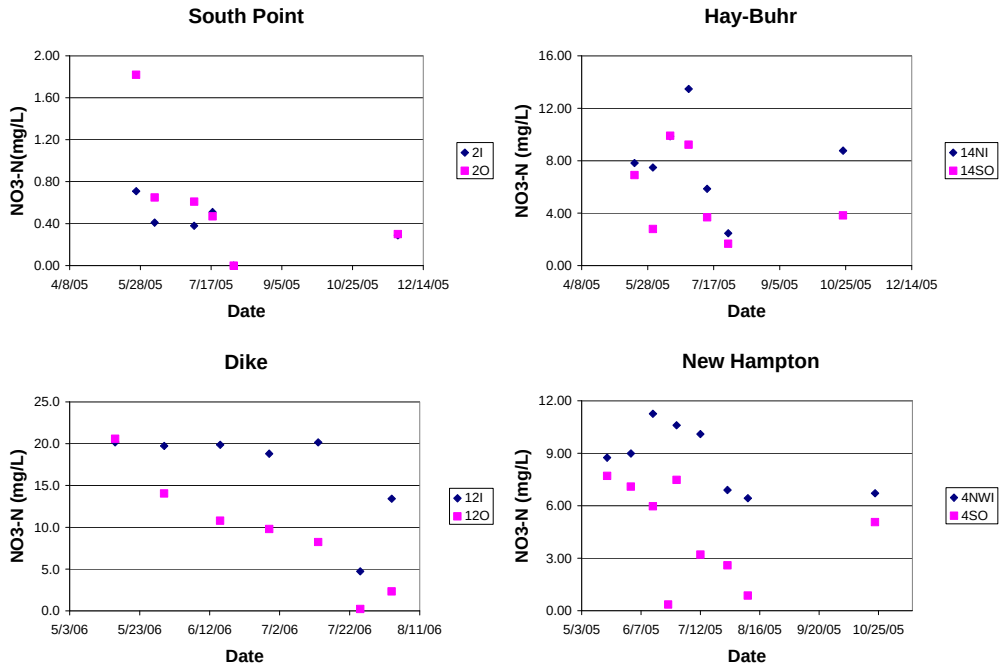
Sites in parentheses were dry; sites in italics were the reference natural wetlands.

Table 3. Isolated vs. connected wetlands – grab samples and outflows only

Analyte	Mean (isolated)	Mean (connected)	Significantly different?[a]	P
DO	10.61	8.23	Yes	0.025
pH	8.32	7.79	Yes	0.004
Conductivity	296	375	Yes	0.007
Turbidity	22.2	14.6	No	0.345
TSS	46.7	8.7	Yes	0.023
DRP	0.26	0.15	No	0.263
Total P	1.35	0.46	Yes	$2.68x10^{-4}$
NH_3	0.15	0.20	No	0.430
Total N	2.53	5.35	Yes	0.010
NO_3^-N	0.31	4.20	Yes	$2.36x10^{-5}$
SO_4^{2-}	15.19	15.32	No	0.970
Cl^-	9.19	22.87	Yes	$4.07x10^{-10}$
COD	64.7	29.2	Yes	0.004

a. Calculated at the 95% confidence level
b. Two-tail t-test assumuing unequal variances

Figure 1. Nitrate removal in selected wetlands.



Appendix 1. Data collected
Appendix 2. Deviations from the Quality Assurance Project Plan

Site	Date	DO	Temp	pH	Turb	Cond	TSS	DRP	Total P	NH3	Total N	NO3	SO4	Cl	COD
Engledinger															
13A	6/7/2005	10.6	30.3	8.04	3.2	458	11.2	0.19	0.45	BDL	BDL	0.33	9.35	11.36	61
13A	6/23/2005	13.2	30.7	7.36	4.0	477	2.4	0.19	NA	BDL	1.10	0.35	13.44	8.22	29
13A	7/5/2005	18.4	27.6	8.10	6.2	713	BDL	0.35	0.24	BDL	1.13	0.42	13.31	6.81	17
13A	7/18/2005	6.4	29.1	7.36	5.0	353	2.4	0.27	0.64	0.05	BDL	0.41	21.55	15.54	37
13A	8/2/2005	4.7	26.1	7.19	NA	553	NA	0.37	0.62	BDL	BDL	BDL	12.78	11.49	22
13A	11/26/2005	18.7	4.7	7.68	NA	390	NA	NA	NA	NA	NA	0.09	39.25	15.23	NA
13B	7/18/2005	20.9	28.5	9.64	41.4	148	67.3	0.31	4.11	0.37	13.44	0.41	3.71	13.40	197
13B	8/2/2005	15.4	27.3	8.91	NA	328	NA	0.13	2.47	0.23	8.53	BDL	3.51	14.99	141
13B	11/26/2005	24.3	3.2	8.18	NA	347	NA	NA	NA	NA	NA	BDL	22.63	27.90	NA
Hay-Buhr															
14NI	5/18/2005	8.0	12.5	7.16	2.8	395	BDL	0.17	0.19	0.05	8.51	7.82	26.10	25.69	22
14NI	6/1/2005	7.7	16.9	7.24	6.7	372	BDL	0.20	0.32	BDL	2.68	7.48	27.91	26.13	34
14NI	6/14/2005	5.9	16.6	7.19	3.4	409	BDL	0.18	0.25	BDL	13.07	9.86	21.73	32.45	60
14NI	6/28/2005	4.9	20.7	7.05	5.7	430	26	0.30	0.44	0.05	15.71	13.47	19.78	24.60	16
14NI	7/12/2005	5.8	21.6	7.27	5.5	376	BDL	0.25	0.22	BDL	6.68	5.86	30.41	25.23	12
14NI	7/28/2005	6.6	20.4	7.26	3.5	498	4.4	0.25	0.34	0.06	3.25	2.47	26.08	25.05	11
14NI	10/23/2005	10.2	8.8	7.44	2.7	504	BDL	NA	0.08	NA	6.32	8.77	34.63	27.93	NA
					4.3							7.96			
14SO	5/18/2005	9.0	14.5	7.45	1.5	374	BDL	0.08	0.23	0.07	7.94	6.91	25.95	29.91	48
14SO	6/1/2005	6.3	23.7	7.88	3.4	335	BDL	0.24	0.53	0.09	9.92	2.79	21.40	27.95	29
14SO	6/14/2005	2.7	19.9	7.04	3.5	369	BDL	0.26	0.51	0.07	5.53	9.90	21.63	32.25	58
14SO	6/28/2005	1.5	22.6	6.92	4.0	368	BDL	0.48	0.71	0.10	11.07	9.23	14.80	17.70	24
14SO	7/12/2005	5.9	23.8	7.20	4.2	388	BDL	0.25	0.24	0.07	5.27	3.68	22.59	28.63	18
14SO	7/28/2005	6.6	21.1	7.23	3.5	406	2	0.27	0.53	BDL	1.85	1.67	9.89	24.56	NA
14SO	10/23/2005	10.8	5.9	7.50	3.8	502	BDL	NA	0.27	NA	2.53	3.83	25.31	37.01	NA
South Point					3.5							5.43			
2I	5/25/2005	26.9	21.9	9.01	9.7	309	17	0.04	0.33	0.05	1.47	0.71	17.33	14.29	40
2I	6/7/2005	3.6	26.8	7.27	14.6	409	8	0.06	0.68	0.37	1.73	0.41	13.36	13.47	76
2I	7/5/2005	2.3	21.0	7.05	29.0	427	15.6	0.13	0.53	0.08	1.46	0.38	4.74	3.42	19
2I	7/18/2005	0.9	24.2	6.97	20.2	275	9.6	0.23	0.72	0.19	1.95	0.51	8.73	10.72	13
2I	8/2/2005	0.7	23.8	6.74	NA	404	NA	0.20	0.91	0.15	2.17	BDL	8.61	13.33	33
2I	11/26/2005	19.3	1.9	7.93	NA	285	NA	NA	NA	NA	NA	0.29	24.83	17.62	NA
												0.46			
2O	5/25/2005	13.9	21.2	8.39	11.7	364	11.5	BDL	0.34	0.05	2.28	1.82	18.93	14.83	36
2O	6/7/2005	11.5	25.7	8.45	20.8	403	18.4	0.04	0.64	0.06	BDL	0.65	17.74	16.49	85
2O	7/5/2005	14.1	28.4	8.77	10.1	560	5.6	0.04	0.25	BDL	1.86	0.61	10.48	9.50	19
2O	7/18/2005	7.0	27.9	7.86	12.6	311	4	0.05	0.52	0.05	1.88	0.47	10.23	11.92	27
2O	8/2/2005	11.3	24.7	8.33	NA	368	NA	0.06	0.78	0.07	2.17	0	10.58	14.91	51
2O	11/26/2005	19.3	1.2	8.00	NA	259	NA	NA	NA	NA	NA	0.30	23.57	16.76	NA
					12.2							0.64			
Site	**Date**	**DO**	**Temp**	**pH**	**Turb**	**Cond**	**TSS**	**DRP**	**Total P**	**NH3**	**Total N**	**NO3**	**SO4**	**Cl**	**COD**
Pleasantville															
3	5/25/2005	6.9	20.6	8.69	29.7	133	38	0.16	0.74	0.06	1.34	0.34	1.91	6.40	65
3	6/7/2005	11.7	28.6	9.22	5.4	149	BDL	0.14	0.36	BDL	3.06	0.36	9.42	11.37	64
3	6/23/2005	7.8	28.5	8.82	7.1	157	BDL	0.21	0.69	BDL	2.65	0.36	1.40	5.63	70
3	7/5/2005	8.9	23.7	8.03	7.9	211	8	0.10	0.63	BDL	1.79	0.34	1.07	4.39	39
3	7/18/2005	3.8	24.5	6.84	24.0	169	8.4	0.07	1.19	0.06	3.31	0.41	1.69	7.51	54
3	8/2/2005	3.6	24.8	6.32	NA	262	NA	0.11	1.50	BDL	3.27	0	2.09	10.42	67
3	11/26/2005	17.3	2.1	6.35	NA	183	NA	NA	NA	NA	NA	0	2.73	18.95	NA

New Hampton					7.9										
4NEI	5/18/2005	8.3	10.2	6.77	9.5	563	2.5	0.29	0.84	0.17	9.58	0.43	24.67	23.20	24
4NEI	6/1/2005	13.3	14.8	7.38	27.0	532	16	0.17	0.65	0.21	14.47	13.43	20.76	41.90	26
4NEI	6/14/2005	8.9	14.0	7.19	5.0	437	BDL	0.22	0.29	0.20	15.33	1.63	19.44	34.24	23
4NEI	6/28/2005	5.6	16.5	6.96	10.4	498	3.2	0.48	0.63	0.29	14.08	12.02	20.20	34.86	15
4NEI	7/12/2005	10.2	19.2	7.51	7.1	492	BDL	0.48	0.59	0.28	15.94	13.28	32.73	38.64	12
4NEI	7/28/2005	7.7	20.4	7.21	4.1	684	3.6	0.52	0.72	0.89	12.10	7.70	32.99	43.64	15
4NEI	8/9/2005	6.6	21.1	7.42	4.9	740	NA	0.56	0.75	0.45	11.98	10.31	46.51	54.45	12
4NEI	10/23/2005	9.8	10.4	7.51	3.8	611	39.6	NA	0.94	NA	8.68	5.07	23.09	28.22	NA
4NWI	5/18/2005	11.8	11.2	7.90	4.8	522	1.5	0.11	0.16	0.06	14.15	8.75	33.37	54.62	29
4NWI	6/1/2005	10.1	19.8	8.23	11.1	479	30	BDL	0.19	0.07	12.10	8.99	31.88	49.27	36
4NWI	6/14/2005	9.3	21.5	7.81	10.5	423	5.2	0.14	0.19	0.05	11.60	23.47	25.30	18.43	5
4NWI	6/28/2005	7.5	22.9	7.56	3.5	440	BDL	0.18	0.23	0.05	12.31	10.60	21.16	28.77	14
4NWI	7/12/2005	12.2	27.5	8.45	3.8	378	2	0.12	0.15	0.07	11.98	10.10	21.35	30.41	7
4NWI	7/28/2005	13.5	25.1	8.52	15.0	439	10	0.04	0.19	BDL	9.17	6.90	19.63	28.26	18
4NWI	8/9/2005	4.3	25.1	7.59	5.0	400	NA	BDL	0.10	0.20	7.81	6.43	24.52	33.68	23
4NWI	10/23/2005	10.5	10.5	7.78	10.4	439	11.6	NA	0.15	NA	4.21	6.71	22.18	29.20	NA
4SI	5/18/2005	7.3	11.5	7.51	6.0	556	2.5	0.52	0.59	0.42	7.36	0.44	24.65	23.24	34
4SI	6/1/2005	10.8	22.5	7.92	6.0	519	14	0.33	1.01	0.06	5.50	0.58	28.62	23.45	31
4SI	6/14/2005	4.1	17.6	7.41	6.6	390	3.2	0.28	0.65	0.49	7.13	1.70	9.37	12.78	40
4SI	6/23/2005	4.2	26.2	7.42	10.7	345	1.2	0.27	0.99	0.09	1.68	0.45	13.38	15.38	48
4SI	6/28/2005	3.2	18.8	7.35	7.8	431	6.8	0.77	1.24	1.62	9.90	5.04	18.19	21.67	23
4SI	7/12/2005	4.6	24.1	7.41	10.1	463	1.2	0.23	0.64	0.55	1.31	0.49	32.33	21.76	4
4SI	7/28/2005	6.3	19.9	7.34	14.4	565	3.6	0.48	0.92	1.39	4.01	0.77	24.14	21.93	4
4SI	8/9/2005	7.8	22.7	7.56	8.3	583	NA	0.34	0.86	0.53	BDL	0.48	26.07	20.51	11
4SI	10/23/2005	9.4	6.8	7.29	15.6	543	15.6	NA	0.68	NA	BDL	0.97	33.12	23.04	NA
Site	**Date**	**DO**	**Temp**	**pH**	**Turb**	**Cond**	**TSS**	**DRP**	**Total P**	**NH3**	**Total N**	**NO3**	**SO4**	**Cl**	**COD**
4SO	5/18/2005	10.6	12.8	7.70	4.4	511	2.5	0.11	0.27	0.16	10.22	7.71	29.41	49.39	23
4SO	6/1/2005	10.9	20.4	8.48	4.4	402	NA	1.50	0.06	0.29	BDL	7.10	BDL	27.81	12.65
4SO	6/14/2005	7.1	22.5	7.45	3.9	445	BDL	0.15	0.35	0.57	6.00	11.10	25.48	35.47	25
4SO	6/23/2005	14.7	28.8	8.68	22.7	368	30.4	BDL	0.71	0.05	1.55	0.35	12.18	14.72	BDL
4SO	6/28/2005	6.0	23.2	7.18	7.9	451	3.6	0.30	0.78	0.49	9.37	7.48	19.10	26.88	16
4SO	7/12/2005	8.1	24.7	7.85	9.7	341	17.6	0.08	0.70	0.12	5.54	3.21	20.20	31.15	BDL
4SO	7/28/2005	6.0	21.5	7.41	5.8	417	5.6	0.23	0.51	0.87	5.10	2.59	18.00	26.77	17
4SO	8/9/2005	5.3	23.4	7.60	3.4	423	NA	0.24	0.44	0.27	BDL	0.86	20.92	32.25	16
4SO	10/23/2005	12.3	7.2	7.45	6.7	366	2	NA	BDL	NA	3.03	5.07	23.09	28.22	NA
Palisades					5.8							5.05			
6NI	5/18/2005	8.8	13.2	7.07	1.1	367	BDL	0.14	0.11	BDL	7.65	7.56	16.10	11.43	23
6NI	6/1/2005	8.2	17.3	7.40	3.7	343	15	0.05	0.18	BDL	7.42	6.55	15.95	11.32	BDL
6NI	6/14/2005	4.6	16.5	6.12	5.8	318	BDL	0.15	1.65	0.08	8.73	13.75	15.72	13.59	121
6NI	6/29/2005	5.4	17.5	6.55	1.0	376	BDL	0.05	0.35	BDL	6.63	5.61	15.04	12.90	35
6NI	7/12/2005	4.4	18.6	7.28	9.6	315	36	0.15	0.18	BDL	5.60	4.24	14.17	9.23	28
6SO	5/18/2005	15.1	17.7	9.06	9.7	236	5.5	0.17	0.76	0.13	1.22	0.54	12.24	11.74	34
6SO	6/1/2005	8.7	21.5	7.68	27.7	318	20.5	0.05	1.10	0.55	3.00	BDL	12.03	13.19	48
6SO	6/14/2005	3.3	24.5	7.43	7.9	320	BDL	0.06	0.23	0.40	1.87	24.76	26.45	38.01	77
6SO	6/29/2005	5.2	26.5	7.86	4.7	267	1.2	BDL	0.23	0.05	1.73	0.52	6.31	12.27	24
6SO	7/12/2005	3.4	26.3	7.53	8.8	188	2.8	BDL	0.19	BDL	BDL	0.39	5.26	11.85	25
6SO	7/28/2005	10.5	23.3	9.09	8.1	178	5.6	0.06	0.25	0.05	BDL	0.47	5.24	14.33	25
6SO	8/10/2005	0.9	25.9	7.76	189.0	203	NA	BDL	1.18	0.46	2.78	0.39	10.22	19.86	62

Site	Date	DO	Temp	pH	Turbidity	Cond	TSS	DRP	Total P	NH3	Total N	Nitrate	Sulfate	Chloride	COD
Wickiup Hill															
7	5/16/2006	7.89	12.51	7.88	55.9	423	52.4	BDL	1.39	0.414	2.4	0.3	20.7	3.9	46
7	5/30/2006	10.64	24.5	7.69	26.8	352	462.8	0.11	3.77	0.378	5.8	0.1	19.0	11.7	299
7	6/15/2006	1.38	19.1	7	98.9	341	107.6	0.24	1.53	1.434	6.8	0.2	11.8	14.6	160
Boevers															
8	5/16/2006	10.22	19.43	8.47	9.53	359	10.4	0.06	1.53	0.146	7.8	4.2	16.4	10.3	38
Badger															
9NW	5/25/2006	8.49	23.27	8	3.97	353	83.2	0.10	2.72	0.281	3.7	0.2	41.4	8.1	NA
9SE	5/25/2006	7.17	22.58	7.85	3.19	173	175.6	0.19	3.14	0.756	4.4	0.1	14.3	3.3	NA
9	6/8/2006	5.52	24.57	8.1	106	533	31.6	0.09	1.06	0.063	NA	0.1	75.9	13.2	60
9	6/22/2006	6.15	27.34	7.95	149	641	106.4	0.69	1.86	0.367	BDL	0.3	>100	18.6	137
Mink															
10Eout	5/16/2006	9.65	19.21	8.3	4.31	265	6.8	0.02	1.29	BDL8	BDL	0.1	16.9	23.0	20
10E	5/30/2006	10.97	24.07	8.96	15.6	214	49.2	0.59	1.36	0.024	1.7	0.1	5.8	3.3	70
10E	6/15/2006	9.13	18.84	8.64	6.49	211	6.4	0.28	0.47	0.055	2.5	0.2	12.6	2.9	44
10E	6/29/2006	17.06	22.12	9.81	9.92	211	56.8	0.29	0.92	0.062	0.5	0.3	3.2	2.6	47
10E	7/13/2006	10.35	25.38	9.26	9.88	177	60.8	0.20	0.49	0.023	1.1	0.6	0.0	4.3	43
10E	7/25/2006	8.57	25.76	8.74	3.81	230	NA	0.34	NA	NA	1.6	0.2	6.9	5.0	32
10E	8/3/2006	13.01	27.22	7.66	29.3	398	46	0.25	2.63	0.069	4.0	0.2	4.2	4.9	44
					9.88										
10W	5/16/2006	11.25	16.5	8.6	5.71	329	6	0.08	0.99	0.07	BDL	0.1	19.3	20.2	12
10W	5/30/2006	11.08	24.6	8.99	7.69	223	BDL	BDL	0.04	BDL	0.7	0.1	16.3	2.8	12
10W	6/15/2006	10.01	19.85	9.24	4.34	139	8.4	0.03	0.03	0.026	1.0	0.2	14.9	3.1	19
10W	6/29/2006	15.24	24.62	9.99	10.8	199	12	0.06	NA	0.038	BDL	0.3	8.6	2.6	22
10W	7/13/2006	10.16	26.94	9.72	4.09	179	1.2	BDL	BDL5	BDL	1.1	0.1	5.2	4.1	25
10W	7/25/2006	9.91	23.57	9.7	1.88	198	NA	0.01	NA	NA	BDL	0.2	9.5	2.6	12
10W	8/3/2006	10.43	26.62	9.72	3.74	194	5.6	0.05	BDL	BDL	1.2	0.2	7.5	2.5	12
Brush															
11C	6/22/2006	1.55	20.84	6.5	21.2	2878	6.8	4.63	5.99	1.609	BDL	2.6	52.7	1050.0	29
11C	7/6/2006	0.4	18.35	7.1	14.9	1577	38	5.97	7.26	NA	5.0	0.7	18.3	371.0	39
11C	7/20/2006	0.31	22.56	7.08	14.4	2046	12.8	12.79	6.58	1.325	4.5	0.0	43.5	*158.5*	33
Site	Date	DO	Temp	pH	Turbidity	Cond	TSS	DRP	Total P	NH3	Total N	Nitrate	Sulfate	Chloride	COD
11I	5/25/2006	3.48	21.36	7.75	3.9	966	1.2	0.18	2.04	0.622	3.1	1.2	46.2	*200.6*	19
11I	6/8/2006	3.9	20.75	7.36	3.34	1385	BDL	0.28	1.46	0.459	4.0	0.5	39.3	*408.7*	23
11I	6/22/2006	0.34	20.8	6.95	16.9	1601	16	2.38	3.37	0.936	BDL	2.4	42.5	730.6	220
11I	7/6/2006	0.16	18.86	7.16	42.8	1364	44	4.85	6.40	NA	12.1	BDL	NA	277.0	42
11I	7/20/2006	0.15	23.67	6.85	10.5	1620	8	5.07	6.15	0.327	1.8	0.3	38.2	*113.2*	37
11I	8/3/2006	0.79	25.81	6.76	8.82	1155	11.2	4.52	7.56	0.713	3.7	0.2	36.4	*220.7*	39
11O	5/25/2006	7.51	22.35	8.87	2.64	758	1.6	1.53	0.37	0.578	1.3	0.3	49.9	*178.6*	19
11O	6/8/2006	1.76	23.2	8.94	1.54	857	1.2	0.32	1.16	0.09	2.6	0.1	27.4	*219.3*	25
11O	6/22/2006	1.85	23.46	8.64	3.48	927	4.8	1.63	2.02	0.09	BDL	2.4	23.2	220.0	27
11O	7/6/2006	1.16	20.66	7.89	10.9	1272	94	3.66	4.61	NA	5.4	BDL	NA	263.4	32
11O	8/3/2006	0.99	28.37	7.3	5.78	1196	28.4	4.01	9.92	0.338	7.7	0.3	33.4	*342.5*	92
					3.48										
11S	7/20/2006	0.26	24.74	6.58	20.2	2294	1284	18.66	8.50	1.688	11.2	BDL	90.8	*130.3*	268
Dike															
12I	5/16/2006	11.14	12.15	8.12	2.16	555	0.8	0.09	1.67	0.042	20.9	20.2	12.7	13.2	6
12I	5/30/2006	9.73	22.25	7.83	13.5	514	18.8	BDL	0.25	0.012	23.7	19.7	13.9	28.1	17
12I	6/15/2006	8.82	16.61	7.2	5.29	439	7.2	0.08	0.05	0.041	20.6	19.9	14.4	28.2	4
12I	6/29/2006	11.11	16.2	7.56	5.53	513	0.4	0.04	NA	0.045	24.4	18.8	11.5	24.5	7

12I	7/13/2006	8.29	17.09	6.98	8.73	466	8	0.06	0.05	BDL6	19.2	20.2	13.7	27.6	15
12I	7/25/2006	8.54	23.19	7.5	9.5	481	NA	0.03	NA	NA	5.3	4.7	15.3	28.2	14
12I	8/3/2006	7.92	18.82	6.62	7.01	563	13.6	0.11	0.04	0.018	14.1	13.4	17.6	25.8	BDL
												16.7			
12O	5/16/2006	10.05	13.15	8.14	8.86	532	24	BDL	1.19	0.082	21.6	20.6	13.0	13.1	14
12O	5/30/2006	6.92	24.49	7.92	4.88	434	1.2	0.04	0.12	BDL	18.0	14.1	13.3	28.9	10
12O	6/15/2006	8.38	20.11	7.77	2.75	322	2	0.02	0.06	0.068	13.5	10.8	13.1	30.2	11
12O	6/29/2006	7.28	22.53	7.58	27.7	NA	24.4	0.04	0.25	0.131	14.7	9.8	10.9	23.8	22
12O	7/13/2006	6.64	23.35	7.33	24.6	359	37.6	0.09	0.25	0.083	10.8	8.2	11.2	32.8	28
12O	7/25/2006	3.21	19.52	6.76	3.32	633	NA	BDL	NA	NA	0.2	0.2	18.1	29.9	24
12O	8/3/2006	5.96	24.82	7.56	19.2	419	33.2	0.07	0.46	0.143	4.7	2.4	10.0	23.2	24
Doolittle					8.86							9.4			
15	5/25/2006	7.1	22.21	7.65	27.7	166	21.6	2.97	4.29	0.043	2.9	0.1	2.5	1.3	187

Appendix 2. Deviations from the QAPP

1. The original sampling plan called for monthly sampling and analysis throughout the year. Due to difficulty in sampling frozen shallow wetlands, this was modified to spring and summer sampling only.

2. A YSI 556 MPS was used for field measurements. This multi-parameter system measures dissolved oxygen, temperature, pH, and conductivity in one unit.

3. The autosampler purchased on this contract was used for ion chromatograph injections. Dionex autosampler vials which incorporate a 2.2 μm filter were used to minimize sample handling.

4. Hach Method 8000, which is a Cr^{+6} based chemical oxygen demand method, was used after the first summer rather than Hach Method 10067. Method 8000 is EPA approved for wastewater analysis, and provides better sensitivity.

5. Engeldinger – for most of the summer of 2005, a small wetland less than ¼ mile from the transect was sampled rather than the wetland in the transect. After discovery of the error, both were sampled.

6. Samples from Brush Creek analyzed by IC contained concentrations of nitrate, sulfate, and chloride which exceeded the highest standard analyzed. This was not discovered until after disposal of the samples. Higher standards were then analyzed, and the method does retain linearity above and beyond the concentrations reported. Nevertheless, those values are italicized in the data report to indicate that they exceeded the standards run that day.

Appendix G

Final Report on the Landscape Assessment of The Ecological Assessment of Compensatory Wetland Mitigation

Final Report on the Landscape Assessment of
The Ecological Assessment of Compensatory Wetland Mitigation

August 2007

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Introduction

In watersheds dominated by row-crop agriculture, wetlands serve as sinks for materials flowing from the surrounding landscape. These materials may include fertilizers, herbicides, pesticides, and sediments. The relative amounts are a function of land use within the watershed and can affect both plant and animal growth and development in the receiving wetland (Dieter 1991, Eulissand Musher 1999, Waters 1995). To assess these impacts over a large number of wetlands in an efficient manner and to gauge the overall ecological functioning of mitigation wetlands, the Iowa Department of Transportation (IDOT) is developing rapid assessment techniques.

As part of this effort, we used a method developed by the Environmental Protection Agency to evaluate wetland conditions at landscape scales (U.S. EPA 2002). We focused on phosphorus, nitrogen, and sediment loads flowing into the wetlands as a function of agricultural run-off.

We also quantified the intensity of human land use in the associated watershed based on the energy use per unit area (Brown and Vivas 2005). In this method, the intensity of land use is compared to that in an undeveloped landscape and expressed as the Landscape Development Index (LDI). Energy use is weighted depending on factors such as whether or not it is a renewable source. Land use types such as residential and commercial consume more non-renewable energy than land cover types such as pasture. The intensity of all land cover/use types are scaled in reference to natural landscape types, which consume zero energy.

Methods

Land use/cover classification

Land use and land cover were delineated using three sets of remotely sensed imagery in ArcMap (ESRI 2005). The three sets provided a range of land use information that was could not be derived from one set of images. The first set comprised color infrared digital orthophotographs (DOQs) from Iowa State University's Geographic Information Systems Support and Research Facilities, the USDA Natural Resource Conservation Service, and the Massachusetts Institute of Technology. These images were derived from aerial photos (1-m resolution) taken March-May of 2002 over the entire state of Iowa. The second image set was obtained from the National Agricultural Imagery Program (NAIP). These DOQs were derived from natural color imagery taken June-October 2004 and have a maximum resolution of two meters per pixel. The primary limitations of this set of orthophotos were resolution and horizontal accuracy. The third set was from low-level aerial photography of each individual research site taken in 2005. The resolution is <1 meter per pixel. The limitation of these georeferenced images was the narrow spatial coverage.

We delineated land use/cover at two different spatial extents. The first extent comprised the area within 300 m of the wetland edge and involved quantification of landscape features at a relatively fine grain. This distance was based on the area thought to serve as core habitat for pond-breeding herpetofauna (Semlitsch and Bodie 2002), one of the focal taxa examined in the overall study. We decided that fine-grain delineation of landscape features beyond 300 m was unnecessary because individual landscape elements, such as isolated hedgerows, do not exert a strong influence on biological activity within the focal wetlands. Rather, at this broader scale (2 km radius) we quantified the dominant land uses and broad categories of land cover. Overall we

focused on land use/land cover categories that were more relevant to the ecological functioning of the mitigation sites.

Ground-truthing of our landscape classifications for the 2005 and 2006 research sites took place in May through July of 2006 and September through October 2006 respectively. Ground-truthing involved a complete survey of each landscape to verify land use and land cover in each patch at each of the two scales. Grassland patches were further subdivided to include a pasture class if we observed grazing animals and a 'managed' class if the parcel was owned by a local, state, or federal conservation/environmental agency. Roadside vegetation was only classified within the 300 m buffer zone.

Confined feeding lots were denoted as such based on the 2006 Iowa Department of Natural Resources Confined Animal Feeding Operations GIS layer. Wetland delineations were based on the remotely-sensed imagery and the U.S. Fish and Wildlife Service National Wetland Inventory data from 1997 and 2002. Final land cover corrections were made on the basis of a digital vegetation cover layer provided by the IDOT. We quantified road density within the 2-km buffer zones. We assessed the total wetland land cover within the local watershed, 300 m, and 2 km buffer.

Local watershed delineation

We delineated the local watershed of each wetland using 1999 National Elevation Data provided by the U.S. Geological Survey and the EROS Data Center in Sioux Falls, SD. The horizontal resolution was 30 meters and the vertical resolution was 15 meters. We used the Iowa Department of Natural Resources Watershed Initiative Data and Natural Resources Conservation Service 2003 Hydrologic Unit Code (HUC) 12 watersheds as our base watersheds.

We used Terrain Analysis Using Digital Elevation Models (TauDEM), a third-party ArcMap extension developed and distributed by David Tarboton at Utah State University, as our watershed-modeling engine. After running the models, we sent the watershed delineations to the respective IDOT mitigation project managers for their assessments. Comments from these managers were then used to modify our original delineations to better represent the local watershed surrounding the mitigation wetlands. However, we could not apply this second tier assessment method to the reference wetlands because no project managers were associated with them. The local watersheds for two mitigation sites (Grooms and Jarvis) had already been delineated by the IDOT. These were considered to be more accurate than our modeled outputs and were used in subsequent analyses.

Sediment and nutrient loads and landscape disturbance index

We calculated the local watershed sediment and nutrient loads based on methods developed by the EPA (U.S.EPA 2002). The EPA nutrient load method is based on six broad categories of land use: Natural, Mostly Natural, Agriculture, Mostly Agriculture, Mostly Urban, and Water. We cross-referenced these categories with our land use/cover categories. For instance, we classified a landscape cover type as cropland, then the equivalent EPA category would have been Agriculture (Appendix C). Our reasoning was that because the Agricultural category had the greatest rate of nutrient loss, cropland would also have the greatest potential loss rates. In addition, sediment risk was based on the amount of agricultural land cover as well as soil properties. Sediment risk was derived from NRCS, and Iowa Department of Natural Resources-Iowa Geological Survey 1998 Highly Erodible Soil (HEL) data and the same Agricultural land classification as the nutrient load calculations.

Calculation of the LDI was based on methods developed by Brown and Vivas (2005). We adapted our classification system to fit their land use categories (See Appendix C). The calculations were based on land use/land cover within the 2-km buffer because the broader delineations and classifications within that area were more conducive to the land use categories of the Brown and Vivas assessment methods. We did not calculate the LDI for the watersheds because most watersheds were within the 2 km buffer and some of the focal taxa may be affected by land use or cover beyond the local watershed.

Landscape context and wetland biodiversity

An indirect ordination technique, correspondence analysis (CA), was used to obtain a general overview of variation in animal taxa among sites, as represented by effective species data. Environmental gradients are not studied directly in indirect ordination analyses, but rather are inferred from the species data. In CA, a reciprocal averaging algorithm orders species and sites along synthetic gradients or axes (ter Braak and Smilauer 1998). This method results in the maximum possible correlation between site and species scores along each axis, subject to the constraint that the axes are orthogonal (Gauch 1982). Thus, CA constructs a theoretical variable, represented by the X axis, that best explains the species data and then, by the same process, constructs a second variable, represented by the Y axis, to explain residual variation (ter Braak 1995).

We used canonical correspondence analysis (CCA), an extension of CA, to examine the relationship between effective species distributions and measured environmental variables. CCA is a direct ordination technique because the axes are constrained to be linear combinations of designated environmental variables; the resulting diagram depicts the relationship between the

abundance of effective species, study sites, and measured environmental gradients (ter Braak and Prentice 1988). By comparing the results of CCA with those of CA, it is possible to evaluate the extent to which patterns in the species data can be explained by the environmental variables that have been measured. Congruent configurations indicate that the appropriate environmental variables have been measured (Økland 1996). Environmental variables were selected by stepwise forward-selection procedures (ter Braak and Smilauer 1998) from a set that included road density (within 2 km); potential nitrogen, phosphorus, and sediment loadings; LDI for 'natural' area (within 2 km); LDI for water (within 2 km); grassland, managed grassland, and woodland (within 300 m); and emergent or forested wetland (within 300 m). Variables explaining a significant amount of variation, as determined by Monte Carlo permutation tests (499 random permutations of the samples in the species data), were included in the CCA analyses and the means of these variables are represented by the origin in the resulting diagram. Because our limited sample size could lead to low power in statistical tests, we used an α-level of 0.20 to screen for significant effects in this analysis.

Results

Land Use/Cover

Agricultural land use, particularly row crops, dominated the landscape surrounding most wetlands. The Doolittle 300-m buffer was dominated by cropland (80% coverage). Engeldinger was dominated by pasture and cropland with a total coverage of approximately 70%. Engeldinger had the least amount of wetland land cover excluding riverine wetlands with 4% coverage. Haye-Buhr had the greatest amount of wetland land cover with 38% coverage. Haye-

Buhr also had the least amount of cropland coverage and greatest amount of broad-leaf deciduous forest coverage (Table 1).

Wetland land cover varied greatly within the 300 m buffer zone. The mitigation sites with >50% cropland coverage at the 300 m buffer zone included South Point, Palisades, Brush Creek, Boevers, Dike, and Mink (Table 2 and 3). Boevers had the greatest amount of wetland land cover with approximately 30% at the 300 m buffer zone. Mink had the least amount of wetland land cover with 0%. New Hampton had the greatest amount of grassland land coverage and Pleasantville had the least with 0%.

At the 2 km land use/cover Engeldinger dominated the cropland land use with 68%. However, Doolittle and Hay-Buhr were comparable in cropland cover with 66% and 60% respectively. None of the reference wetlands were dominated by residential land cover (Table 4). Haye-Buhr had the greatest amount of broad-leaf deciduous land cover at the 2 km buffer zone with 17% coverage.

At the 2 km buffer zone, Brush, Boevers, Dike, Mink, and Palisades had >50% coverage of cropland. Grooms had the least amount of cropland land coverage with 14%.Wickiup Hill had the greatest diversity of land use/coverage with 16 different types (Table 5). Boevers and Wickiup Hill had approximately 19% wetland land coverage. New Hampton had the greatest amount of grassland land coverage with 44%. Pleasantville and Jarvis have the greatest amount of broad-leaf deciduous land coverage (28%) while Dike had the least with 0%.

Grooms had the smallest road density at 8.75 m/ha at the 2 km buffer. The greatest road density at the same parameters was Brush creek with a density of 22 m/ha. The reference wetland road density for Doolittle, Engeldinger, and Haye-Buhr was 13, 19, and 11 m/ha respectively. The average road density among the mitigation sites was 14 m/ha (Table 6).

Watershed soils, land use, nutrient, and sediment loads

The reference wetland (Haye-Buhr, Engldinger, and Doolittle) watersheds were 165 ha, 110 ha, 59 ha in size, respectively. Doolittle had a nutrient loading value greater than Engeldinger or Haye-Buhr, which was a result of the greater amount of cropland in the surrounding landscape (Table 7). In contrast, Engeldinger Marsh had the greatest percentage of Natural and Water land cover within its watershed and the least amount of Agriculture (Table 8). Doolittle lacked Highly Erodible Land within the watershed and therefore had no risk of sediment loading. Haye-Buhr and Engldinger both had relatively low risk of sediment loading (1% and 4% respectively).

The mitigation wetland watershed sizes were highly variable in comparison to the reference watersheds. The mitigation wetland watersheds ranged from 3.71 ha (Boevers) to 590 ha (Brush) in area, and their nitrogen and phosphorus loadings ranged from 2.23 to 1.51 and 3.65 to 2.18 respectively. Boevers had the greatest nutrient loading values of all the mitigation wetland sites and the greatest amount of agriculture land use (Table 7). The Boevers watershed comprised no natural lands and only 5.42% was in wetland coverage. Jarvis had the lowest nutrient loading values (1.51 for nitrogen and 2.18 for phosphorus). Jarvis also had the greatest percentage of watershed area in natural and wetland land cover (24% and 16%, respectively). All of the mitigation site watersheds exceeded 50% agricultural use, except Jarvis and Wickiup (Table 8).

The sediment risk loads of the mitigation wetlands ranged from 0% to 46% (Table 7). Boevers and Mink had the lowest values because they lacked Highly Erodible Lands (HEL) within the watershed. Brush Creek had the highest sediment risk loading, with 7.49% of the

wetlands edge adjacent to agricultural lands and 38.66% of the watershed as HEL. Badger had the seconded highest sediment risk, with none of the wetland edge bordering agriculture but with >43% of its watershed as HEL.

Landscape development index

LDI values for the reference sites ranged from 3.4 to 4.8 (Table 9). Haye-Buhr had the lowest value and the greatest percentage of natural land cover (>21%) and open water (nearly 9%) within 2 km of the wetland edge. Engeldinger and Doolittle had comparable row-crop land use (67% and 68%, respectively). Engeldinger also had the greatest amount of single-family land use at 6% coverage. The Doolittle watershed had two confined feeding lots, but still had only 1% high intensity agriculture coverage.

LDI values for mitigation sites ranged from 2.62 to 5.33 (Tables 10 and 11). Wickiup Hill had the lowest LDI value and the greatest combined percentage of natural land cover and open water (56%). New Hampton had the greatest index value and the lowest combined percentage of these land-cover classes (6%). Dike had the greatest amount of row crop (76%). Brush Creek had a confined feeding lot (Agriculture high-intensity) that is contributing to 0.25% land coverage. New Hampton, Mink, Boevers, and Dike had >50% of their watersheds in row crop agriculture. New Hampton had the greatest amount of residential land cover at 11% of the 2 km buffer.

Landscape context and wetland biodiversity

The primary axis of variation in the CA, which accounted for 58.9% of the variation in species composition, segregated sites based on (Fig. 1). The secondary axis accounted for an

additional 17.6% of the variation in species composition. Notably, the reference sites varied little from one another along the first axis, but were clearly differentiated along the second axis.

The distribution of sites in the CCA (Fig. 2) was quite different compared to that in the CA, suggesting that important sources of variation were not captured by the selected environmental variables. Interestingly, the distribution of effective species was similar between the two analyses, with the more vagile taxa (Amphibia, Reptilia, Aves, and Mammalia) along situated on the right side of Axis I in the CCA; the location of Lepitdoptera was the exception in the CCA, but not the CA. There was substantial variation among sites on both axes. The percentage of variation in species composition explained by the first two axes was 29.3%, substantially less than that explained by the first two axes in the CA. There were significant relationships between species composition and three environmental variables, one describing the intensity of row-crop agriculture within 2 km of the wetlands (intraset correlations of -0.51 with Axis I and -0.86 with Axis II) and the other two reflecting the amount of grassland (intraset correlations of 0.55 with Axis I and -0.16 with Axis II) and wetland (intraset correlations of 0.62 with Axis I and -0.36 with Axis II) within 300 m. Thus, the primary axis had moderately strong, positive correlations with potential habitat in the landscape immediately surrounding the sites, and a moderately strong negative correlation with row-crops within 2 km. The second axis reflected a very strong negative correlation with row-crops. Both the first canonical axis and the overall relationship between species and environmental variables (all canonical axes) were significantly different from those derived from randomized data ($P < 0.10$), based on Monte Carlo permutation tests.

Discussion

The small sample size and other limitations of studies conducted over broad spatial scales, such as lack of randomization and true replication, constrains our ability to draw broad inferences from this study. Nonetheless, a number of points emerge that should be considered in the future when selecting mitigation sites in this region. The land use/cover that lies within the local watershed can had a strong relationship with the nutrient and sediment loads potentially flowing into the mitigation sites. The local watersheds that were dominated by agricultural uses had the greatest nutrient and sediment load potentials. However, the land use/cover within a 2 km buffer zone did not having a strong negative influence on the LDI. All the sites except New Hampton had LDI values below 5.0, reflecting the predominance of of row-crop agriculture, which had the greatest influence on the nutrient and sediment loads, in the surrounding landscapes. Therefore, when considering the land-use context of candidate mitigation sites the ideal would be more natural or semi-natural land cover. This is admittedly somewhat rare in Iowa, but efforts should be made to select sites with a little row-crop agriculture within the local watershed and a minimal amount within the 2 km buffer.

Soil characteristics that promote erodability and the total length of the wetland edge bordering agricultural land influenced potential sediment loads within the watersheds. The percentage of wetland edge adjacent to agricultural land increased influenced loads by the same amount. For example, a wetland that has no HEL soils in the local watershed but is completely surrounded by agriculture has a 100% sediment risk. Choosing mitigation sites with lower areas of HEL soils can reduce the sediment risk on a wetland, but creating a vegetation buffer around the wetland edge can have a greater effect of decreasing the potential sediment loads. There is

evidence to suggest that switchgrass (*Panicum virgatum*) alone or in combination with woody plant cover can mitigate soil erosion when planted in 7.1 or 16.3 m widths (Lee et al. 2000).

Road density is increasingly used to gauge landscape effects on amphibians (Fahrig et al. 1995, Hels and Buchwald 2001). The degree to which road density affects biota in this study is unknown. However, Eagen and Paton (unpublished data 2005) found that in New England there was a negative effect on pond breeding amphibians when road densities exceeded 14%. In this study, five mitigation sites and one reference site (Engeldinger) had road densities above this threshold. Other studies have found that traffic mortality, road avoidance, and road salt runoff can have a negative affect on animal populations associated with wetlands (Forman and Deblinger 2000), especial vagile species such as amphibians (Carr and Fahrig 2001). Findlay and Houlahan (1997) reported that road density was negatively correlated with the species richness of birds, herpetofauna, and plants but not mammals.

The results of the ordinations were both surprising and somewhat frustrating. The correspondence analysis, unconstrained by environmental variables, accounted for a very high amount of variation in patterns of biodiversity at these wetlands. Identifying the sources of variation as reflected in two-dimensional space is, however, somewhat elusive. Although we included a number of variables in the constrained analysis that other studies have identified as exerting a strong influence on wetland biodiversity, particularly for vertebrates, there were clearly important sources of variation that were not accounted for. This said, explaining nearly 30% of the variation in animal distributions is non-trivial, given the statistical 'noise' typically associated with community data. It is possible that other sources of variation at landscape scales exist but were not included in the CCA. We think it is more likely, however, that a clearer

picture of the important drivers of biodiversity at these sites may have emerged if local habitat variables had also been included in the analysis.

Limitations imposed by remotely sensed imagery should be taken into consideration when considering the results reported here. The spatial resolution of the National Elevation Data is somewhat coarse for landscapes in much of Iowa. Nonetheless, these were the best elevation data available for the region. In addition, these data do not reflect changes in the landscape stemming from features such as elevated roads or quarries. Landscape structures of this sort alter surface flows and nutrient and sediment loads by diverting water to or away from a wetland. The review of the watersheds by project managers was done to ensure that the delineations were as accurate as possible given these data limitations.

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Table 1. Total hectares of each class name per reference wetland for the 300-m buffer land use/cover delineations.

Wetland	Class_Name	Hectares	Percent
Doolittle	Cropland	59.76	79.19%
	Grassland	2.27	3.01%
	Grassland_managed	3.80	5.04%
	Palustrine_Emergent_Wetland	9.29	12.31%
	Road_Side_Vegetation	0.35	0.46%
Engdinger	BLD	6.44	11.86%
	Cropland	25.25	46.50%
	Grassland_managed	2.97	5.46%
	Palustrine_Emergent_wetland	2.04	3.75%
	Palustrine_Unconsolidated_bottom	0.18	0.32%
	Pasture	12.48	22.99%
	Residential_Low_Density	1.36	2.51%
	Riverine_System	1.10	2.03%
	Roads_Secondary	0.23	0.42%
	Roads_Tertiary	0.98	1.81%
	Roadside_vegetation	1.27	2.35%
Haye Buhr	BLD	69.84	28.40%
	Cropland	56.14	22.83%
	Grassland	5.88	2.39%
	Grassland_managed	3.65	1.49%
	Palustrine_Emergent_Wetland	82.61	33.60%
	Palustrine_Forested_Wetland	3.48	1.42%
	Palustrine_Unconsolidated_bottom	8.06	3.28%
	Pasture	4.13	1.68%
	Residential_Low_Density	3.49	1.42%
	Riverine_Lower_Perennial_Unconsolidated_bottom	0.70	0.28%
	Roads_Secondary	5.72	2.33%
	Roadside_Vegetation	2.20	0.89%

Table 2. Total hectares of each class name per 2005 mitigation wetland for the 300-m buffer land use/cover delineations.

Wetland	Class_Name	Hectares	Percent
Grooms	BLD	2.53	2.21%
	Cropland	47.54	41.54%
	Grassland	28.98	25.33%
	Grassland_managed	2.13	1.86%
	Palustrine_Emergent_Wetland	26.37	23.05%
	Palustrine_Unconsolidated_bottom	2.16	1.89%
	Residential_Low_Density	4.72	4.12%
Jarvis	BLD	30.09	19.29%
	Cropland	31.08	19.93%
	Grassland	18.13	11.63%
	Palustrine_Emergent_Wetland	6.66	4.27%
	Palustrine_System	4.12	2.64%
	Pasture	4.56	2.93%
	Residential_Low_Density	1.36	0.87%
	Riverine_System	15.22	9.76%
	Roads_Primary	1.39	0.89%
	Roads_Secondary	1.11	0.71%
	Roadside_Vegetation	0.78	0.50%
	Woodland	41.45	26.58%
Pallisades	BLD	0.67	1.34%
	Cropland	27.11	53.91%
	Grasland_managed	6.11	12.14%
	Grassland	2.35	4.67%
	Palustrine_Emergent_Wetland	0.96	1.91%
	Palustrine_unconsolidated_bottom	0.83	1.65%
	Pasture	0.57	1.13%
	Residential_Low_Density	2.23	4.44%
	Roads_Primary	4.21	8.36%
	Roadside_Vegetation	5.25	10.44%
Pleasantville			
	BLD	15.31	30.12%
	Cropland	23.64	46.52%
	Grassland	3.24	6.38%
	Palustrine_Unconsolidated_bottom	1.43	2.81%
	Pasture	0.27	0.53%
	Riverine_System	1.78	3.51%
	Roads_Primary	1.24	2.43%
	Roadside_Vegetation	3.91	7.69%
New Hampton			

	Barnyard	0.18	0.25%
	BLD	1.98	2.77%
	Cropland	15.94	22.32%
	Grassland	32.04	44.87%
	NLE	0.60	0.85%
	Palustrine_Emergent_Wetland	2.35	3.29%
	Palustrine_Unconsolidated_bottom	4.93	6.91%
	Primary_Roads	4.57	6.40%
	Roadside_Vegetation	8.81	12.34%
South Point			
	BLD	6.63	9.23%
	Cropland	57.66	80.23%
	Palustrine_System	4.74	6.60%
	Pasture	2.83	3.94%

Table 3. Total hectares of each class name per 2006 mitigation wetland for the 300-m buffer land use/cover delineations.

Wetland	Class_Name	Hectares	Percent
Badger	BLD	46.96	30.80%
	Cropland	37.51	24.60%
	Grassland	36.70	24.07%
	Palustrine_Unconsolidated_bottom	29.97	19.65%
	Residential_Low_Density	1.36	0.89%
Brush	BLD	2.34	2.28%
	Cropland	40.29	39.27%
	Grassland	32.22	31.41%
	NLE	0.97	0.94%
	Palustrine_Emergent_Wetland	6.41	6.25%
	Palustrine_Forested_Wetland	0.52	0.50%
	Palustrine_Unconsolidated_bottom	3.81	3.72%
	Roads_Primary	2.39	2.33%
	Roadside_Vegetation	6.60	6.44%
	Woodland	7.04	6.86%
Mink	BLD	0.77	1.05%
	Cropland	35.05	47.74%
	Grassland	29.95	40.79%
	Medium_Low_Density_Residential	2.59	3.52%
	Roads_Primary	4.27	5.82%
	Roadside_vegetation	0.79	1.07%
Wickiup	BLD	25.94	33.00%
	Cropland	13.32	16.94%
	Grassland	27.86	35.44%
	Grassland_managed	0.77	0.98%
	Palustrine_Emergent_Wetland	4.23	5.38%
	Palustrine_Forested_Wetland_BLD	0.44	0.56%
	Palustrine_Unconsolidated_bottom	4.44	5.65%
	Residential_Low_Density	0.17	0.21%
	Road_Secondary	1.44	1.83%
Boevers	BLD	4.07	9.42%
	Cropland	26.00	60.27%
	Palustrine_Forested_Wetland	9.58	22.22%
	Palustrine_Unconsolidated_Bottom	3.49	8.09%
Dike	Cropland	33.14	48.06%
	Grassland	24.26	35.18%
	Palustrine_Unconsolidated_Bottom	5.71	8.28%
	Riverine_Lower_Perennial_Unconsolidated_bottom	1.08	1.56%
	Roads_Primary	4.78	6.92%

Table 4. Total hectares of each class name per reference wetland for the 2-km buffer land use/cover delineations.

Wetland	Class_Name	Hectares	Percent
Doolittle	BLD	202.95	13.37%
	Confined_Feeding_Lot	13.56	0.89%
	Cropland	1026.40	67.63%
	Grassland	223.37	14.72%
	Grassland_managed	12.26	0.81%
	Industrial	4.10	0.27%
	Palustrine_Emergent_Wetland	4.08	0.27%
	Residential_Low_Density	12.64	0.83%
	Residential_Medium_Low_Density	4.98	0.33%
	Roads_Primary	13.27	0.87%
Engeldinger	BLD	82.88	4.86%
	Cropland	1138.95	66.78%
	Grassland	143.77	8.43%
	Grassland_managed	103.28	6.06%
	NLE	3.02	0.18%
	Palustrine_Emergent_Wetland	27.77	1.63%
	Palustrine_Unconsolidated_bottom	8.34	0.49%
	Residential_Low_Density	105.59	6.19%
	Roads_Primary	50.81	2.98%
	Savanna	40.99	2.40%
Haye-Buhr	BLD	371.82	17.20%
	Cropland	1309.17	60.57%
	Grassland	129.43	5.99%
	Grassland_managed	89.44	4.14%
	Palustrine_Emergent_Wetland	102.67	4.75%
	Palustrine_Forested_Wetland	3.48	0.16%
	Palustrine_Scrub_Shrub	8.14	0.38%
	Palustrine_Unconsolidated_bottom	30.51	1.41%
	Pasture	22.69	1.05%
	Residential_Low_Density	48.79	2.26%
	Riverine_Lower_Perennial_Unconsolidated_bottom	45.41	2.10%

Table 5. Total hectares of each class name per 2006 mitigation wetland for the 2-km buffer land use/cover delineations.

Wetland	Class_Name	Hectares	Percent
Badger	BLD	457.87	24.47%
	Commercial	3.94	0.21%
	Cropland	764.73	40.87%
	Grassland	526.41	28.13%
	NLE	1.58	0.08%
	Palustrine_Emergent_Wetland	1.04	0.06%
	Palustrine_Unconsolidated_bottom	37.35	2.00%
	Pasture	34.06	1.82%
	Residential_Low_Density	12.43	0.66%
	Residential_Medium_Low_Density	15.81	0.84%
	Roads_Primary	12.32	0.66%
	Woodland	3.65	0.20%
Brush		11.35	0.67%
	BLD	17.95	1.05%
	Commercial	4.17	0.24%
	Confined_Feeding_Lots	4.61	0.27%
	Cropland	1021.91	59.96%
	Grassland	224.90	13.20%
	Palustrine_Emergent_Wetland	6.41	0.38%
	Palustrine_Unconsolidated_Bottom	6.85	0.40%
	Pasture	153.29	8.99%
	Residential_Low_Density	24.21	1.42%
	Residential_Medium_Density	97.38	5.71%
	Roads_Primary	44.12	2.59%
	Savanna	38.53	2.26%
	Woodland	48.54	2.85%
Boevers	Cropland	2.80	0.21%
	BLD	78.08	5.79%
	Confined_feeding_lot	1.34	0.10%
	Cropland	914.47	67.82%
	Grassland	71.71	5.32%
	Palustrine_Emergent_Wetland	17.51	1.30%
	Palustrine_Forested_Wetland	227.82	16.90%
	Palustrine_Unconsolidated_Bottom	15.37	1.14%
	Residential_Low_Density	19.32	1.43%
Dike	Agricultural_Infrastructure	4.34	0.29%
	Cropland	1126.91	75.82%
	Grassland	200.66	13.50%
	Industrial	6.65	0.45%
	Palustrine_Emergent_Wetland	1.06	0.07%
	Palustrine_Unconsolidated_Bottom	23.53	1.58%

	Residential_Low_Density	13.24	0.89%
	Residential_Medium_Density	69.84	4.70%
	Roads_Primary	40.02	2.69%
Mink	BLD	222.44	14.45%
	Cropland	938.14	60.94%
	Grassland	189.23	12.29%
	Low_Density_Residential	22.81	1.48%
	Palustrine_Emergent_Wetland	4.03	0.26%
	Palustrine_Unconsolidated_bottom	4.58	0.30%
	Pasture	21.15	1.37%
	Residential_Medium_Low_Density	28.78	1.87%
	Riverine_Lower_Perennial_Unconsolidated_bottom	27.70	1.80%
	Roads_Primary	45.90	2.98%
	Savanna	11.13	0.72%
	Woodland	23.61	1.53%
Wickiup Hill		0.93	0.06%
	BLD	360.22	23.37%
	Cropland	291.68	18.92%
	Grassland	235.55	15.28%
	Grassland_managed	16.25	1.05%
	Industrial	17.69	1.15%
	Lacustrine_Unconsolidated_bottom	12.64	0.82%
	Palustrine_Emergent_Wetland	30.92	2.01%
	Palustrine_Forested_Wetland_BLD	259.13	16.81%
	Palustrine_Unconsolidated_bottom	8.50	0.55%
	Palustrine_Unconsolidated_bottom_sand	9.25	0.60%
	Pasture	2.20	0.14%
	Residential_Low_Density	16.98	1.10%
	Residential_Medium_Low_Density	124.91	8.10%
	Riverine_Lower_Perennial_Unconsolidated_bottom	75.42	4.89%
	Savanna	21.71	1.41%
	Woodland	57.40	3.72%

Table 6. The total road distance (m), total area of the 2-km buffers (ha), and the road density within the buffer for each wetland (m/ha).

Wetland	Total Linear Roads (meters)	2 km Buffer area (hectares)	Road density m/ha
Grooms	12385	1416	8.75
South Point	13338	1495	8.92
Pleasantville	14481	1376	10.52
Haye-Buhr	22876	2158	10.60
Mink Creek	18319	1502	12.20
Palisades	17467	1388	12.58
Doolittle	19827	1518	13.06
Jarvis	26125	1970	13.26
Badger	25040	1871	13.38
Boevers	20133	1348	14.94
Wickiup Hill	24010	1540	15.59
Engeldinger	32049	1703	18.82
Dike	28477	1486	19.16
New Hampton	30734	1503	20.45
Brush Creek	36960	1683	21.96

Table 7. Nutrient and Sediment loadings for twelve mitigation wetlands and three reference wetlands.

Wetland	Nitrogen	Phosphorus	Sediment
Engeldinger	1.42	1.93	0.04
Doolittle	2.06	3.29	0.00
Haye-Buhr	1.91	3.00	0.01
Grooms	1.89	2.91	0.04
Jarvis	1.51	2.18	0.01
New Hampton	2.10	3.47	0.01
Palisades	1.88	2.90	0.27
Pleasantville	2.04	3.27	0.15
South Point	1.77	2.74	0.11
Wickiup Hill	1.27	1.64	0.16
Brush	2.02	3.30	0.46
Badger	1.66	2.43	0.43
Mink	2.09	3.37	0.00
Dike	2.19	3.57	0.02
Boevers	2.23	3.65	0.00

Table 8. The percentage of each EPA land cover type within a wetland's local watershed.

Wetland	Total Watershed Area ha	%Natural	%Mostly Natural	%Agricultural	%Mostly Ag	%Mostly Urban	%Water/Wetlands
Engldinger	109.59	46.99	0.00	23.35	0.00	2.35	27.32
Doolittle	58.72	13.03	0.00	84.31	0.00	0.00	2.65
Haye-Buhr	164.92	20.07	0.00	58.21	0.00	4.51	17.21
Grooms	15.50	24.00	0.00	62.36	0.00	0.48	13.15
Jarvis	130.67	45.99	0.00	29.90	0.00	7.80	16.32
New Hampton	360.94	5.99	0.00	79.23	0.00	12.73	2.05
Palisades	22.62	26.10	0.00	65.92	0.00	0.06	7.92
Pleasantville	46.97	13.34	0.00	79.11	0.00	3.25	4.30
South Point	373.16	33.28	0.00	55.33	0.00	9.32	2.07
Wickiup Hill	286.74	74.39	0.00	17.00	0.00	7.22	1.39
Brush	590.17	12.27	0.00	72.34	0.00	12.78	2.60
Badger	109.10	45.54	0.00	53.56	0.00	0.00	0.90
Mink	165.73	9.97	0.00	84.34	0.00	1.52	4.17
Dike	408.39	2.70	0.00	95.99	0.00	1.16	0.14
Boevers	3.71	0.00	0.00	94.58	0.00	0.00	5.42

Table 9. The landscape development index for the reference sites for the 2-km buffer.

Land Use	Hectares	% of Total Land Use	LDI Coefficients	LDI
Haye_Buhr				
Improved Pasture (without live stock)	129.43	5.99%	2.77	0.17
Improved Pasture Low Intensity (with live stock)	22.69	1.05%	3.41	0.04
Natural System	461.26	21.34%	1	0.21
Natural Open Water	190.20	8.80%	1	0.09
Rowcrop	1309.17	60.57%	4.54	2.75
Single Family Low Intensity	48.79	2.26%	6.9	0.16
Total	**2161.54**	**100.00%**		**3.41**
Doolittle				
Agriculture high intensity	14	0.92%	7	0.06
Highway(4 lane)	13	0.86%	8.28	0.07
Improved Pasture (without live stock)	223	14.70%	2.77	0.41
Industrial	4	0.26%	8.32	0.02
Single Family medium Intensity	5	0.33%	7.47	0.02
Natural System	215	14.17%	1	0.14
Natural Open Water	4	0.26%	1	0.00
Rowcrop	1026	67.63%	4.54	3.07
Single Family Low Intensity	13	0.86%	6.9	0.06
Total	**1517**	**100.00%**		**3.86**
Engeldinger				
Highway(4 lane)	51	2.99%	8.28	0.25
Improved Pasture (without live stock)	144	8.44%	2.77	0.23
Natural System	230	13.48%	1	0.13
Natural Open Water	36	2.11%	1	0.02
Rowcrop	1139	66.76%	4.54	3.03
Single Family Low Intensity	106	6.21%	6.9	0.43
Total	**1706**	**100.00%**		**4.10**

Table 10. The landscape development index for the 2005 mitigation sites for the 2-km buffer.

Land Use	Hectares	% of Total Land Use	LDI Coefficients	LDI
South Point				
Rowcrop	566.91	37.94%	4.54	1.72
Natural System	525.35	35.16%	1	0.35
Natural Open Water	118.51	7.93%	1	0.08
Improved pasture without livestock	191.52	12.82%	3.41	0.44
Single Family residential low density	54.88	3.67%	6.9	0.25
Highway (4 lanes)	37.15	2.49%	8.28	0.21
Total	**1494.32**	**100.00%**		**3.05**
Grooms				
Improved Pasture Low Intensity (with live stock)	706.93	47.48%	3.41	1.62
Natural System	463.85	31.15%	1	0.31
Natural Open Water	10.53	0.71%	1	0.01
Rowcrop	228.54	15.35%	4.54	0.70
Single Family Low Intensity	79.06	5.31%	6.9	0.37
Total	**1488.91**	**100.00%**		**3.00**
Pleasantville				
Improved Pasture (without live stock)	142.62	10.35%	2.77	0.29
Improved Pasture Low Intensity (with live stock)	64.42	4.67%	3.41	0.16
Natural System	459	33.30%	1	0.33
Natural Open Water	55.44	4.02%	1	0.04
Rowcrop	622.44	45.16%	4.54	2.05
Single Family Low Intensity	34.5	2.50%	6.9	0.17
Total	**1378.42**	**100.00%**		**3.04**
New Hampton				
Improved Pasture (without live stock)	139.75	6.27%	2.77	0.17
Improved Pasture Low Intensity (with live stock)	4.72	0.21%	3.41	0.01
Low Intensity Commercial	173.42	7.79%	8	0.62

Natural System	115.97	5.21%	1	0.05
Natural Open Water	17.07	0.77%	1	0.01
Rowcrop	1262.13	56.67%	4.54	2.57
Low intensity commercial	173.42	7.79%	8	0.62
Highway (4 lanes)	82.88	3.72%	8.28	0.31
Industrial	10.77	0.48%	8.32	0.04
Multifamily residential (low rise)	203.22	9.12%	8.66	0.79
Single Family Low Intensity	43.82	1.97%	6.9	0.14
Total	**2227.17**	**100.00%**		**5.33**
Jarvis				
Improved Pasture (without live stock)	117.51	5.88%	2.77	0.16
Improved Pasture Low Intensity (with live stock)	143.39	7.18%	3.41	0.24
Low Intensity Commercial	2.53	0.13%	8	0.01
Natural System	618.71	30.96%	1	0.31
Natural Open Water	96.29	4.82%	1	0.05
Rowcrop	917	45.89%	4.54	2.08
Single Family Low Intensity	102.8	5.14%	6.9	0.35
Total	**1998.23**	**100.00%**		**3.21**
Palisades				
Highway(4 lane)	21	1.41%	8.28	0.12
Improved Pasture (without live stock)	68.3315	4.58%	2.77	0.13
Improved Pasture Low Intensity (with live stock)	32.6132	2.19%	3.41	0.07
Industrial	1.8252	0.12%	8.32	0.01
Natural System	327.8776	21.99%	1	0.22
Natural Open Water	4.2039	0.28%	1	0.00
Rowcrop	1006.3222	67.49%	4.54	3.06
Single Family Low Intensity	28.9526	1.94%	6.9	0.13
Total	**1491.1262**	**100.00%**		**3.64**

Table 11. The landscape development index for the 2006 mitigation sites.

Land Use	Hectares	% of Total Land Use	LDI Coefficients	LDI
Wickiup Hill				
Improved Pasture (without live stock)	235.54	15.30%	2.77	0.42
Improved Pasture Low Intensity (with live stock)	2.2	0.14%	3.41	0.00
Industrial	17.6	1.14%	8.32	0.10
Natural System	456	29.62%	1	0.30
Natural Open Water	395	25.66%	1	0.26
Rowcrop	292	18.97%	4.54	0.86
Single Family medium density	124	8.06%	7.47	0.60
Single Family Low density	17	1.10%	6.9	0.08
Total	**1539.34**	**100.00%**		**2.62**
Brush Creek				
Agriculture high intensity	**4**	0.24%	**7**	0.02
Highway(4 lane)	44	2.60%	8.28	0.22
Improved Pasture (without live stock)	225	13.31%	2.77	0.37
Improved Pasture Low Intensity (with live stock)	153	9.05%	3.41	0.31
Low intensity Commercial	4	0.24%	8	0.02
Single Family medium Intensity	97	5.74%	7.47	0.43
Natural System	105	6.21%	1	0.06
Natural Open Water	13	0.77%	1	0.01
Rowcrop	1022	60.44%	4.54	2.74
Single Family Low Intensity	24	1.42%	6.9	0.10
Total	**1691**	**100.00%**		**4.27**
Badger Creek				
Highway	12	0.64%	7.81	0.05
Improved Pasture (without live stock)	526	28.13%	2.77	0.78
Improved Pasture Low Intensity (with live stock)	34	1.82%	3.41	0.06
Low intensity Commercial	4	0.21%	8	0.02

Single Family medium Intensity	16	0.86%	7.47	0.06
Natural System	463	24.76%	1	0.25
Natural Open Water	38	2.03%	1	0.02
Rowcrop	765	40.91%	4.54	1.86
Single Family Low Intensity	12	0.64%	6.9	0.04
Total	**1870**	**100.00%**		**3.14**
Mink				
Highway(4 lane)	4	0.27%	8.28	0.02
Improved Pasture (without live stock)	189	12.87%	2.77	0.36
Improved Pasture Low Intensity (with live stock)	21	1.43%	3.41	0.05
Single Family medium Intensity	29	1.97%	7.47	0.15
Natural System	257	17.49%	1	0.17
Natural Open Water	8	0.54%	1	0.01
Rowcrop	938	63.85%	4.54	2.90
Single Family Low Intensity	23	1.57%	6.9	0.11
Total	**1469**	**100.00%**		**3.76**
Boevers				
Improved Pasture (without live stock)	72	5.36%	2.77	0.15
Natural System	78	5.80%	1	0.06
Natural Open Water	261	19.42%	1	0.19
Rowcrop	914	68.01%	4.54	3.09
Single Family Low Intensity	19	1.41%	6.9	0.10
Total	**1344**	**100.00%**		**3.59**
Dike				
Highway(4 lane)	40	2.69%	8.28	0.22
Improved Pasture (without live stock)	201	13.52%	2.77	0.37
Industrial	7	0.47%	8.32	0.04
Low intensity commercial	4	0.27%	8	0.02
Natural Open Water	25	1.68%	1	0.02
Rowcrop	1127	75.79%	4.54	3.44
Single Family Medium Intensity	70	4.71%	7.47	0.35
Single Family Low Intensity	13	0.87%	6.9	0.06

Total	**1487**	**100.00%**	**4.53**

Table 12. Total hectares of each class name per 2005 mitigation wetland for the 2-km buffer land use/cover delineations.

Wetland	Class_Name	Hectares	Percent
Grooms	BLD	449.53	27.55%
	Cropland	228.54	14.00%
	Grassland_managed	4.94	0.30%
	NLE	7.80	0.48%
	Palustrine_Emergent_wetland	0.00	0.00%
	Palustrine_Unconsolidated_bottom	10.54	0.65%
	Pasture	666.71	40.85%
	Residential_Low_Density	65.10	3.99%
	Woodland	6.54	0.40%
New Hampton	BLD	18.83	1.43%
	Commercial	173.42	13.21%
	Cropland	467.44	35.61%
	Grassland	194.15	14.79%
	Grassland_managed	17.43	1.33%
	Industrial	10.77	0.82%
	Low_Density_Residential	43.83	3.34%
	NLE	2.32	0.18%
	Palustrine_Emergent_wetland	0.00	0.00%
	Palustrine_Unconsolidated_bottom	16.42	1.25%
	Pasture	4.72	0.36%
	Primary_Roads	82.88	6.31%
	Residential_Medium-High_Density	203.22	15.48%
	Roadside_Vegetation	9.62	0.73%
	Woodland	67.77	5.16%
Palisades	BLD	295.62	19.83%
	Cropland	1006.32	67.51%
	Grassland	68.33	4.58%
	Grassland_managed	5.91	0.40%
	Industrial	1.83	0.12%
	Palustrine_Emergent_Wetland	1.03	0.07%
	Palustrine_unconsolidated_bottom	3.18	0.21%
	Pasture	32.61	2.19%
	Residential_Low_Density	28.95	1.94%
	Roads_Primary	20.50	1.38%
	Woodland	26.35	1.77%
Pleasantville	BLD	392.06	28.44%
	Cropland	622.44	45.16%
	Grassland	142.62	10.35%
	Palustrine_Algal	0.39	0.03%
	Palustrine_Forested_BLD	30.34	2.20%

	Palustrine_Unconsolidated_bottom	4.66	0.34%
	Pasture	64.42	4.67%
	Residential_Low_Density	34.50	2.50%
	Riverine	20.05	1.45%
	Woodland	66.94	4.86%
Jarvis			
	BLD	594.58	27.72%
	Commercial	2.53	0.12%
	Cropland	912.58	42.55%
	Grassland	117.51	5.48%
	Grassland_managed	16.27	0.76%
	Palustrine_Emergent_Wetland	5.13	0.24%
	Palustrine_Forasted_wetland	0.22	0.01%
	Palustrine_Unconsolidated_bottom	24.23	1.13%
	Pasture	143.40	6.69%
	Residential_Low_Density	62.62	2.92%
	Riverine_System	74.36	3.47%
	Roadside_Vegetation	7.41	0.35%
	Woodland	183.98	8.58%
South Point	BLD	112.07	7.50%
	Cropland	566.92	37.94%
	Grassland	191.52	12.82%
	Grassland_Managed	411.53	27.54%
	NLE	1.74	0.12%
	Palustrine_Emergent_Wetland	8.60	0.58%
	Palustrine_Forested_Wetland_BLD	88.34	5.91%
	Palustrine_Unconsolidated_bottom	21.57	1.44%
	Primary_Roads	37.15	2.49%
	Residential_Low_Density	54.88	3.67%

Figure Legends

Figure 1. Locations of site scores for reference and mitigation sites in the space defined by a correspondence analysis of effective species composition in 2005-2006.

Figure 2. Locations of the scores for reference and mitigation sites in the space defined by a canonical correspondence analysis of effective species composition during 2005-2006. Environmental variables (LDIR = LDI rowcrop; terr300 = grassland, managed grassland, and woodland within 300 m of a wetland; wet300 = emergent or forested wetlands within 300 m of a wetland) are depicted as vectors and the rank of a site with respect to a given variable is approximated by projecting the site point in the diagram perpendicularly onto the environmental vector. The lengths of the arrows indicate the relative importance of each environmental variable in the model and the direction of each arrow indicates how well the environmental variable is correlated with each axis. The origin (0,0) is the mean of each environmental variable, so that transects projecting onto the axis of, but on the side opposite of, the arrow are inferred to exhibit a lower than average value of the variable.

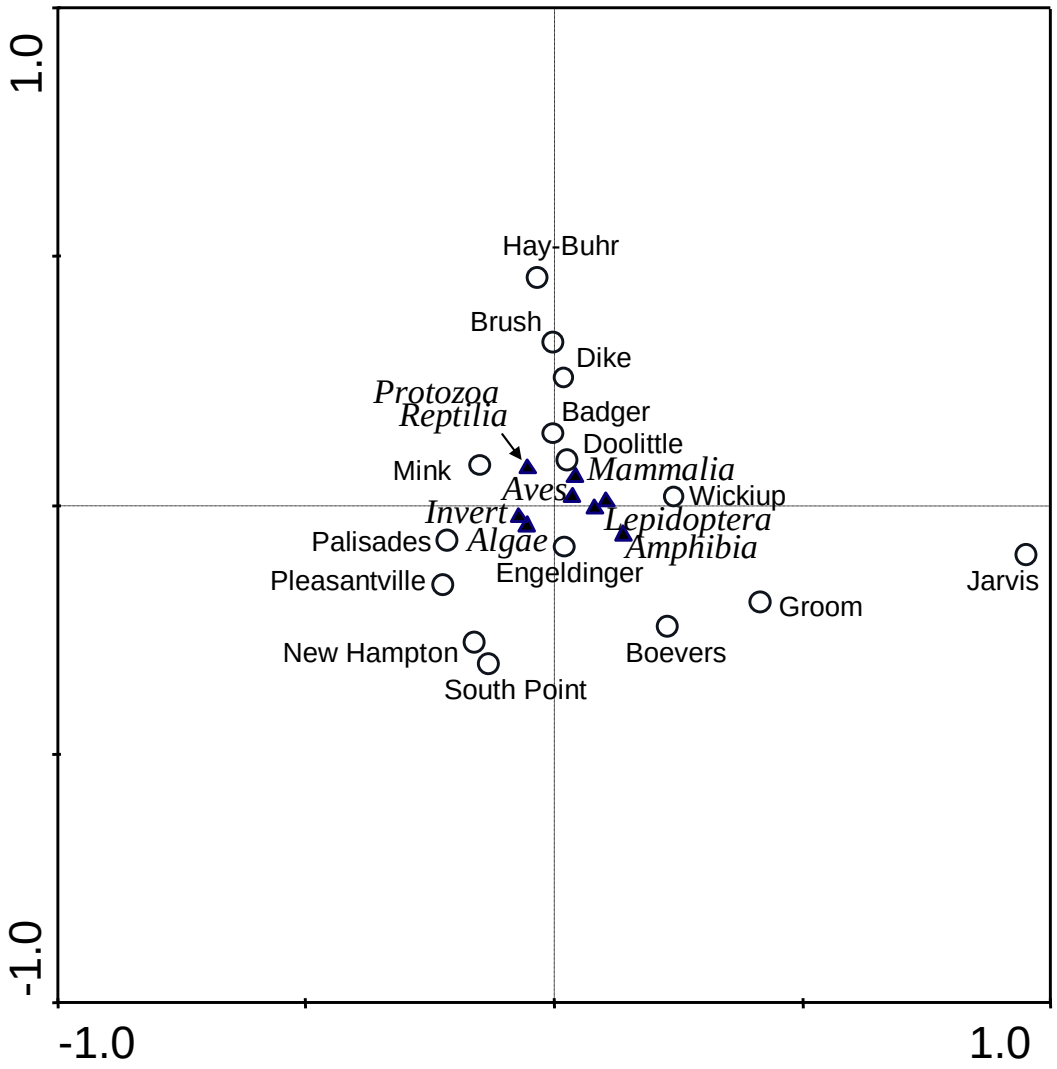

1.0
-1.0
-1.0
1.0
Hay-Buhr
Brush
Dike
Protozoa
Reptilia
Badger
Doolittle
Mink
Mammalia
Aves
Wickiup
Invert
Lepidoptera
Palisades
Algae
Amphibia
Engeldinger
Pleasantville
Jarvis
Groom
Boevers
New Hampton
South Point

Figure 1.

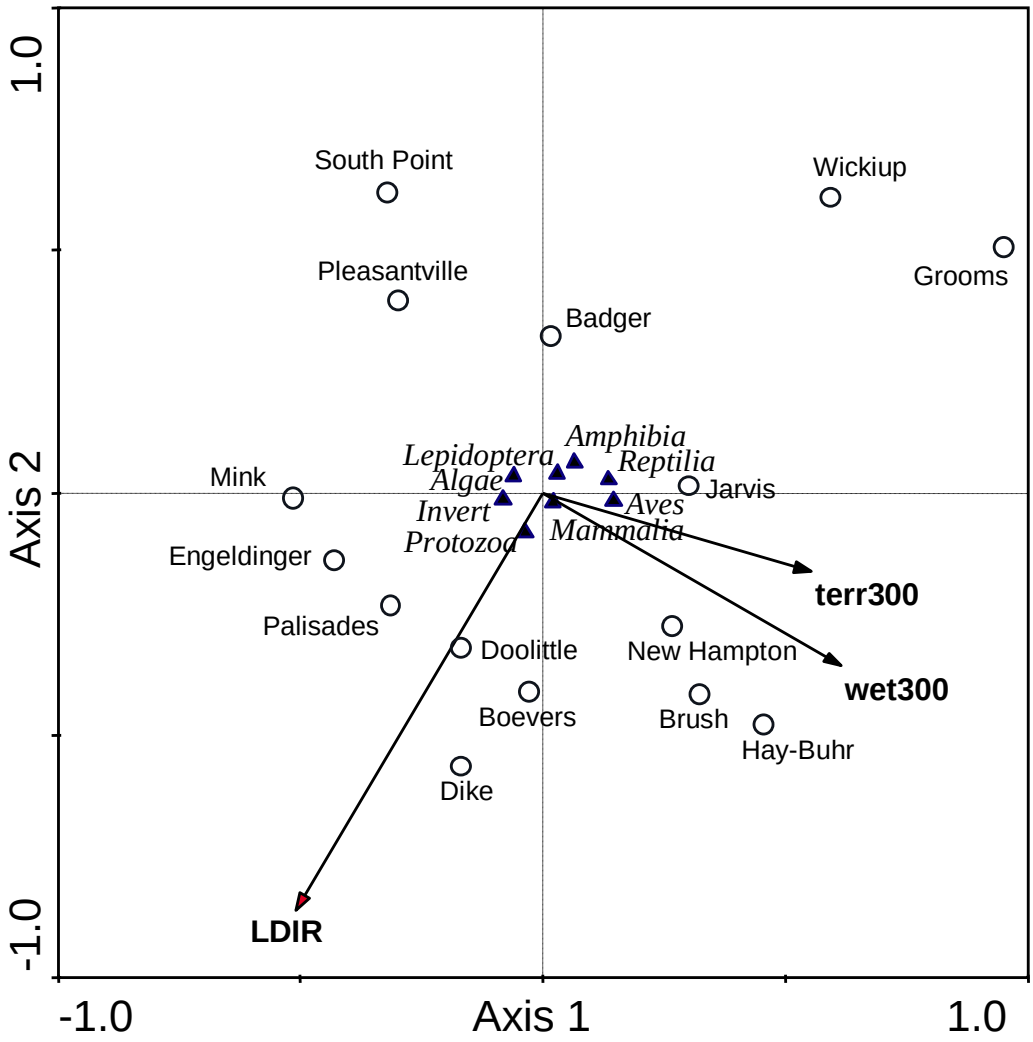

1.0
Axis 2
-1.0
South Point
Wickiup
Grooms
Pleasantville
Badger
Amphibia
Lepidoptera
Reptilia
Algae
Jarvis
Mink
Invert
Aves
Protozoa
Mammalia
Engeldinger
terr300
Palisades
Doolittle
New Hampton
wet300
Boevers
Brush
Hay-Buhr
Dike
LDIR
-1.0
Axis 1
1.0

Figure 2.

Appendix A. Mitigation and reference wetlands (see disk).

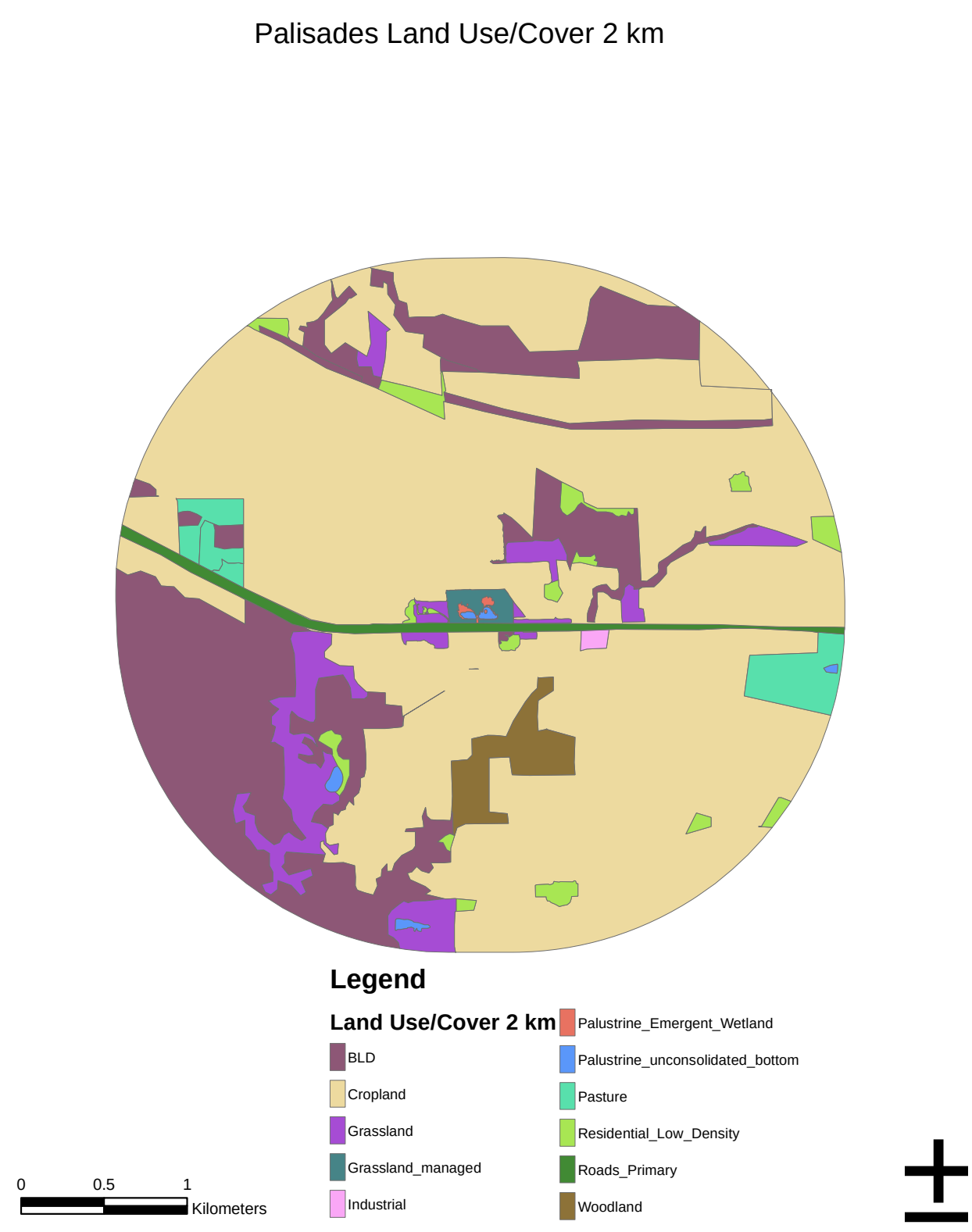


Figure 1 Palisades land use/cover within 2 km of the wetlands edge.

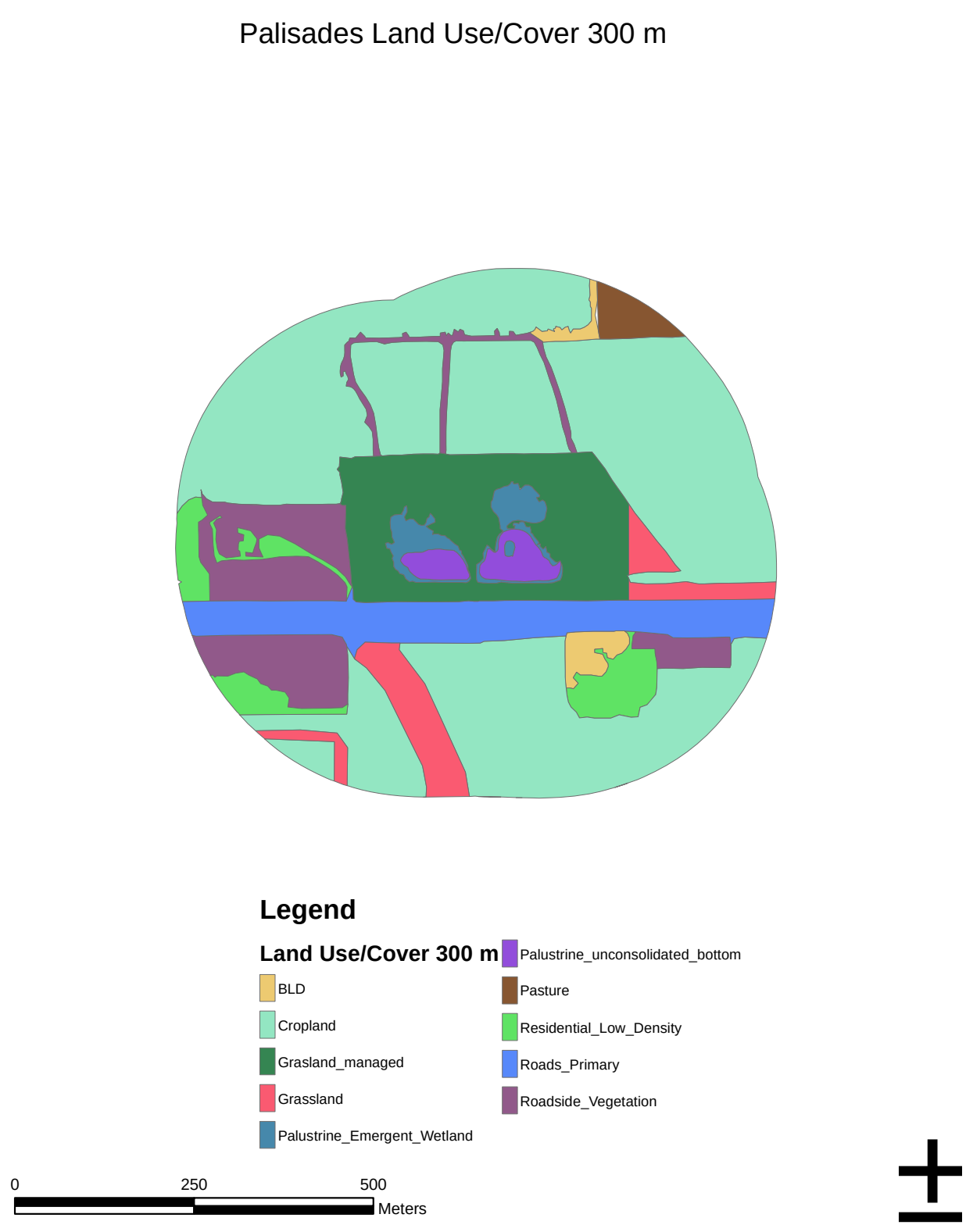


Figure 2 Palisades land use/cover within 300 m of the wetlands edge.

Figure 3 Palisades local watershed and wetland boundary.

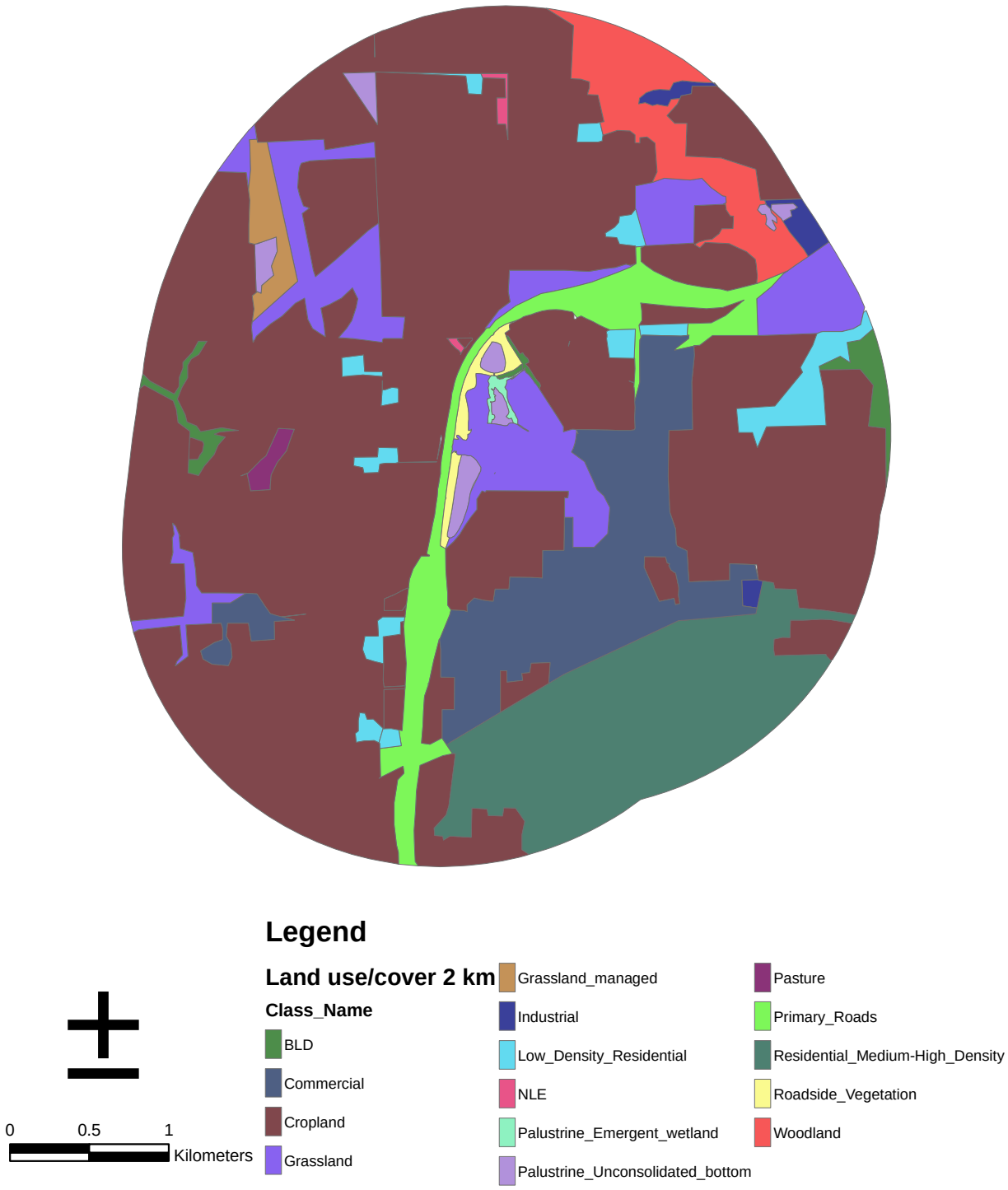


Figure 4 New Hampton land use/cover within 2 km of the wetlands edge.

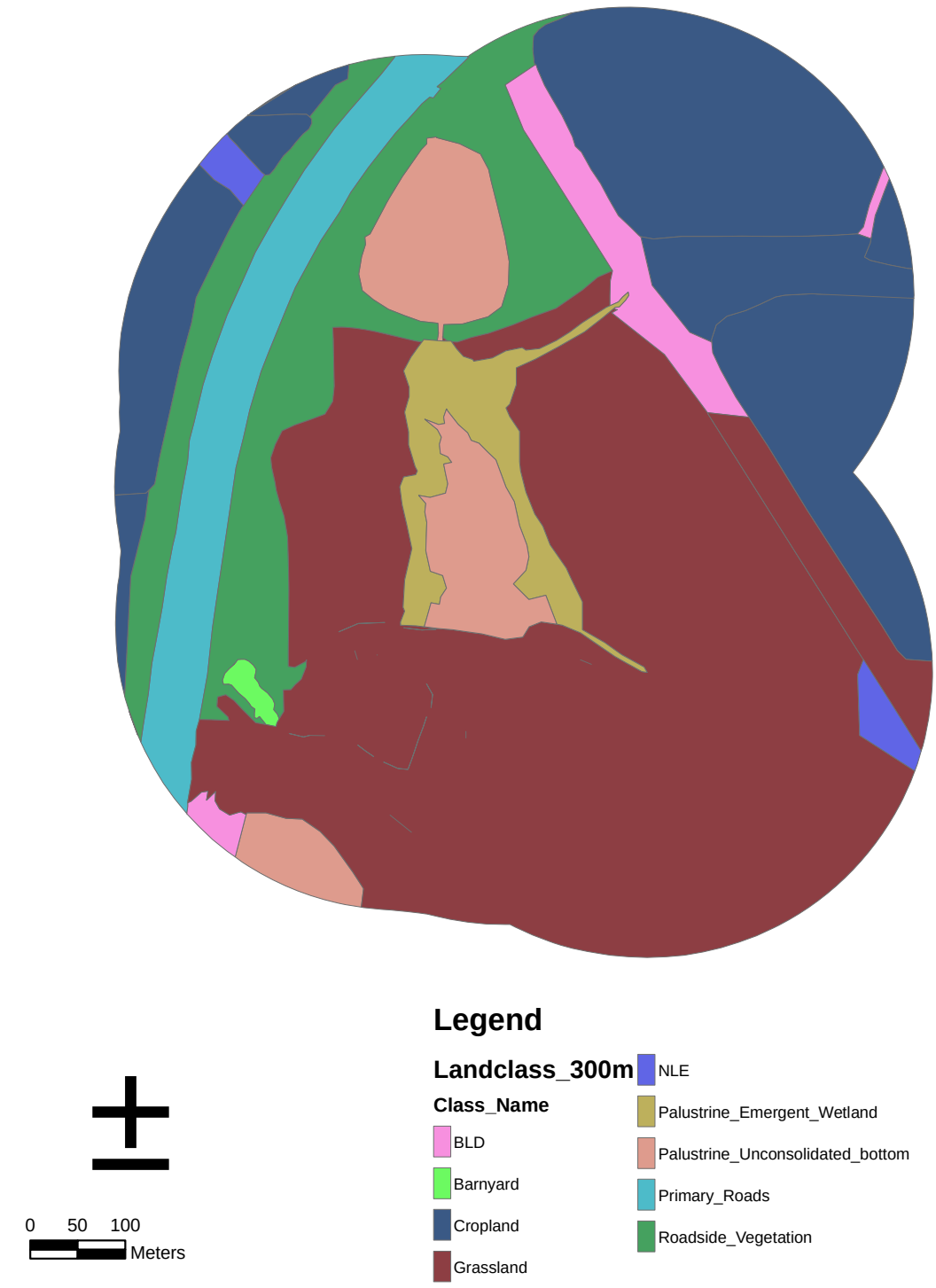


Figure 5 New Hampton land use/cover within 300 m of the wetlands edge.

New Hampton Local Watershed

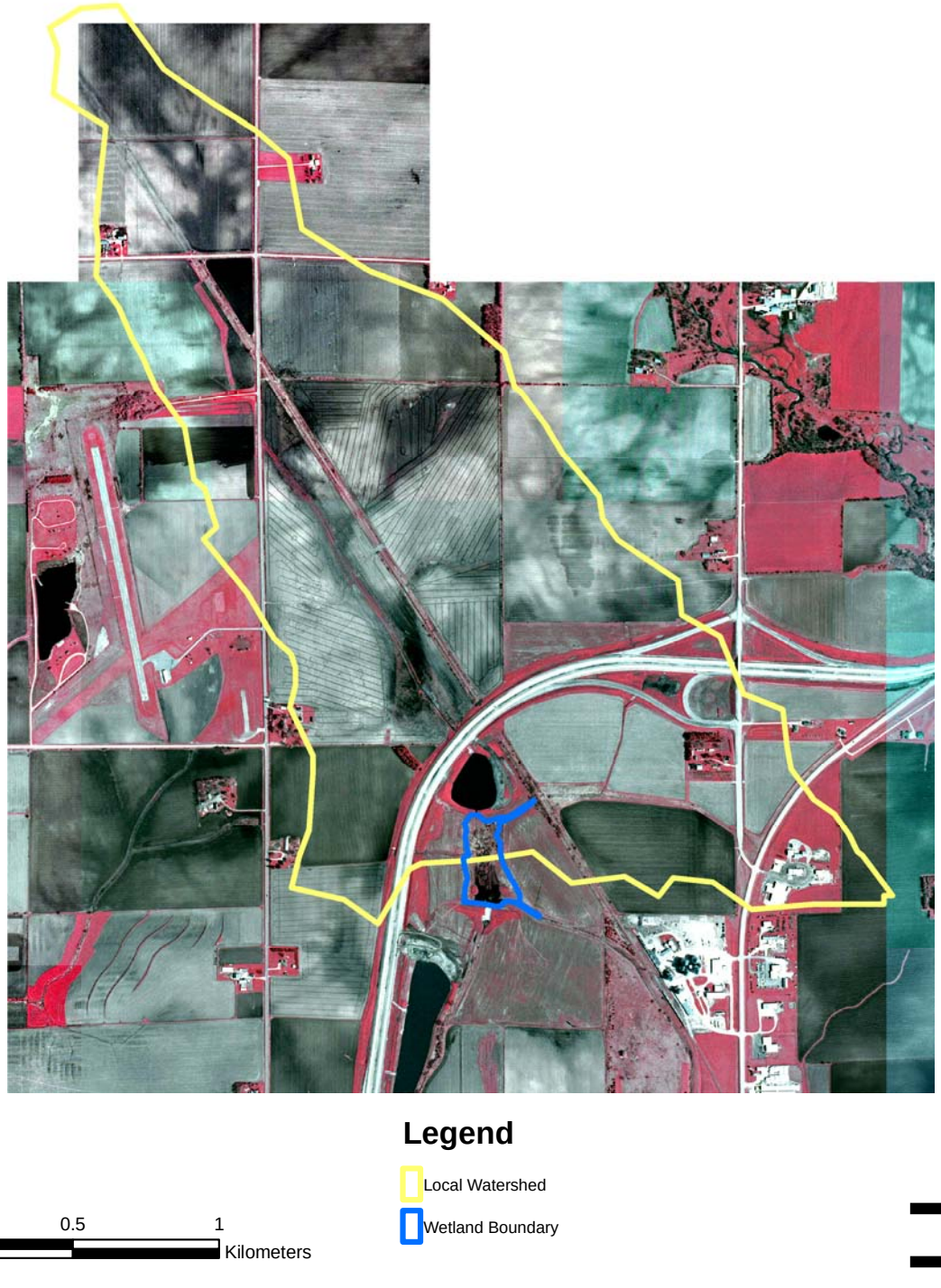


Figure 6 New Hampton local watershed and wetland boundary.

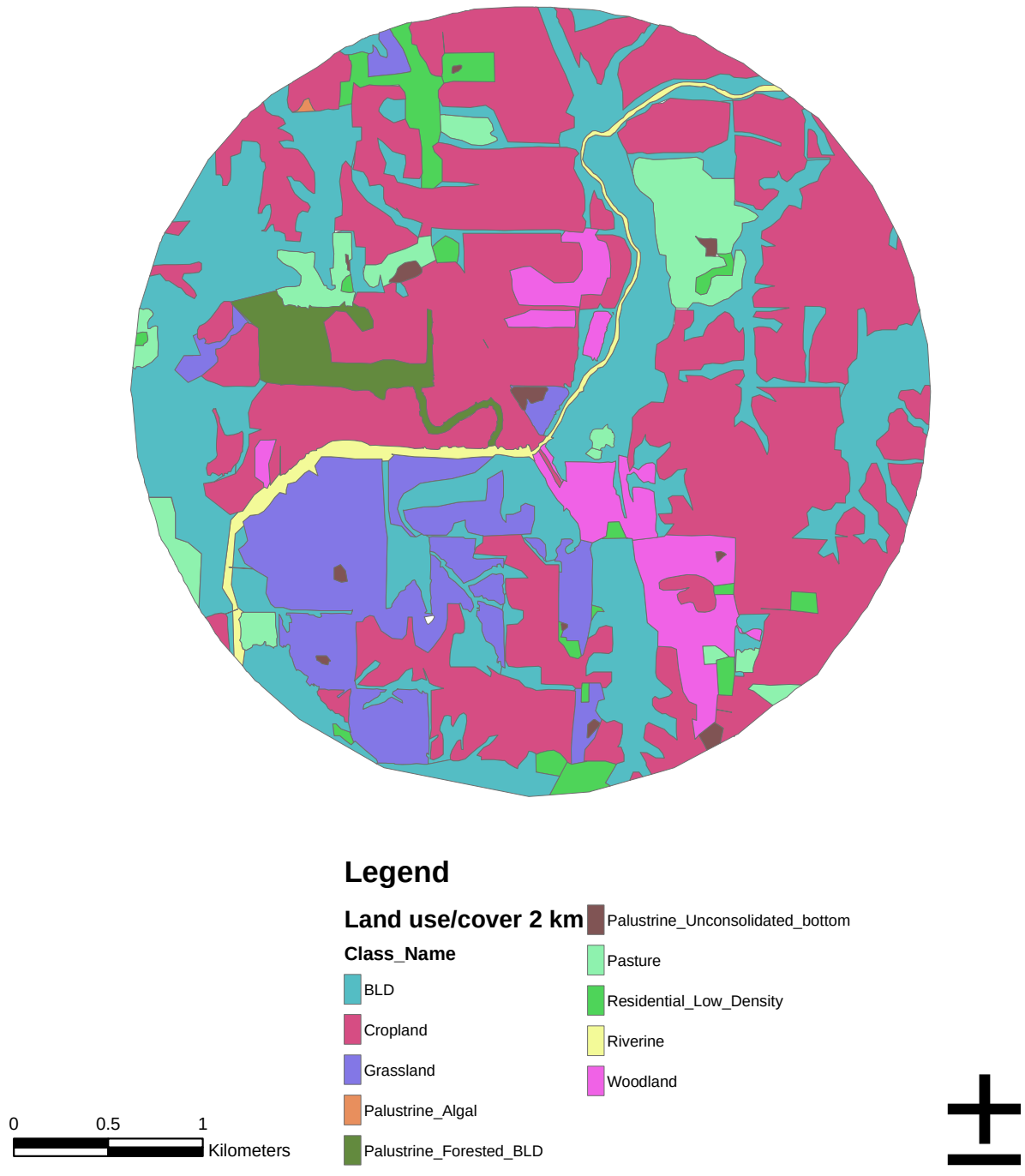


Figure 7 Pleasantville land use/cover within 2 km of the wetlands edge.

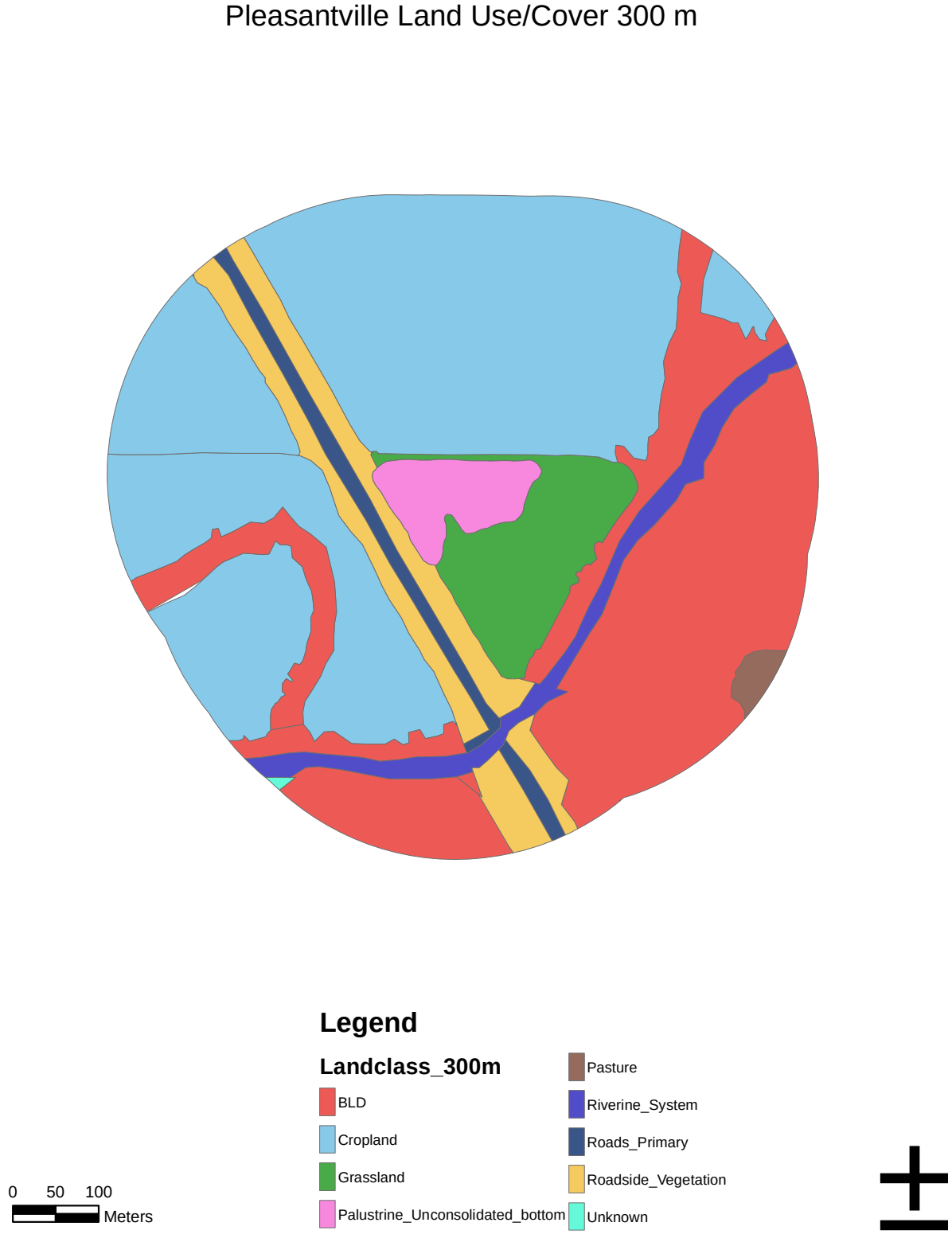


Figure 8 Pleasantville land use/cover within 300 m of the wetlands edge.

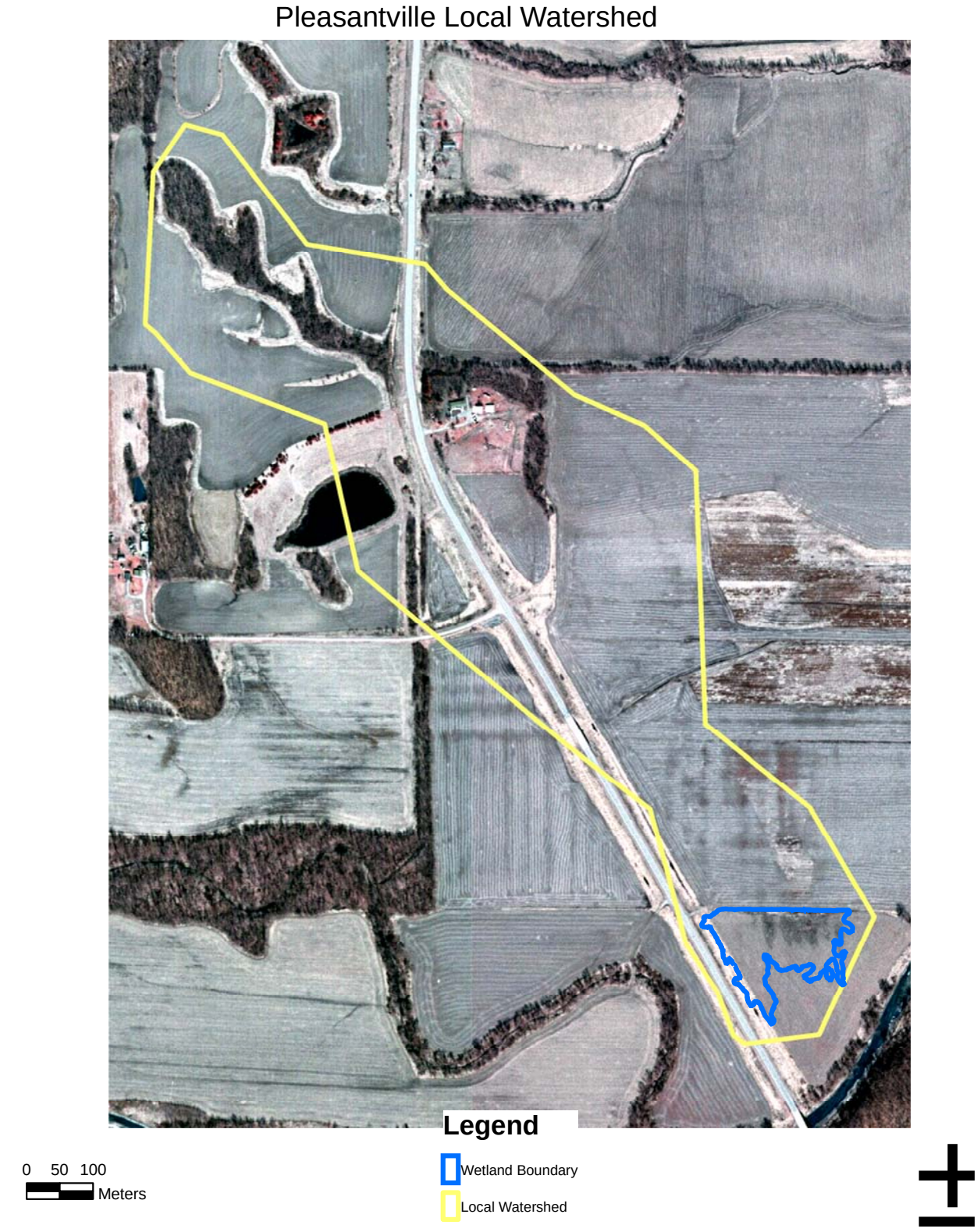


Figure 9 Pleasantville local watershed and wetland boundary.

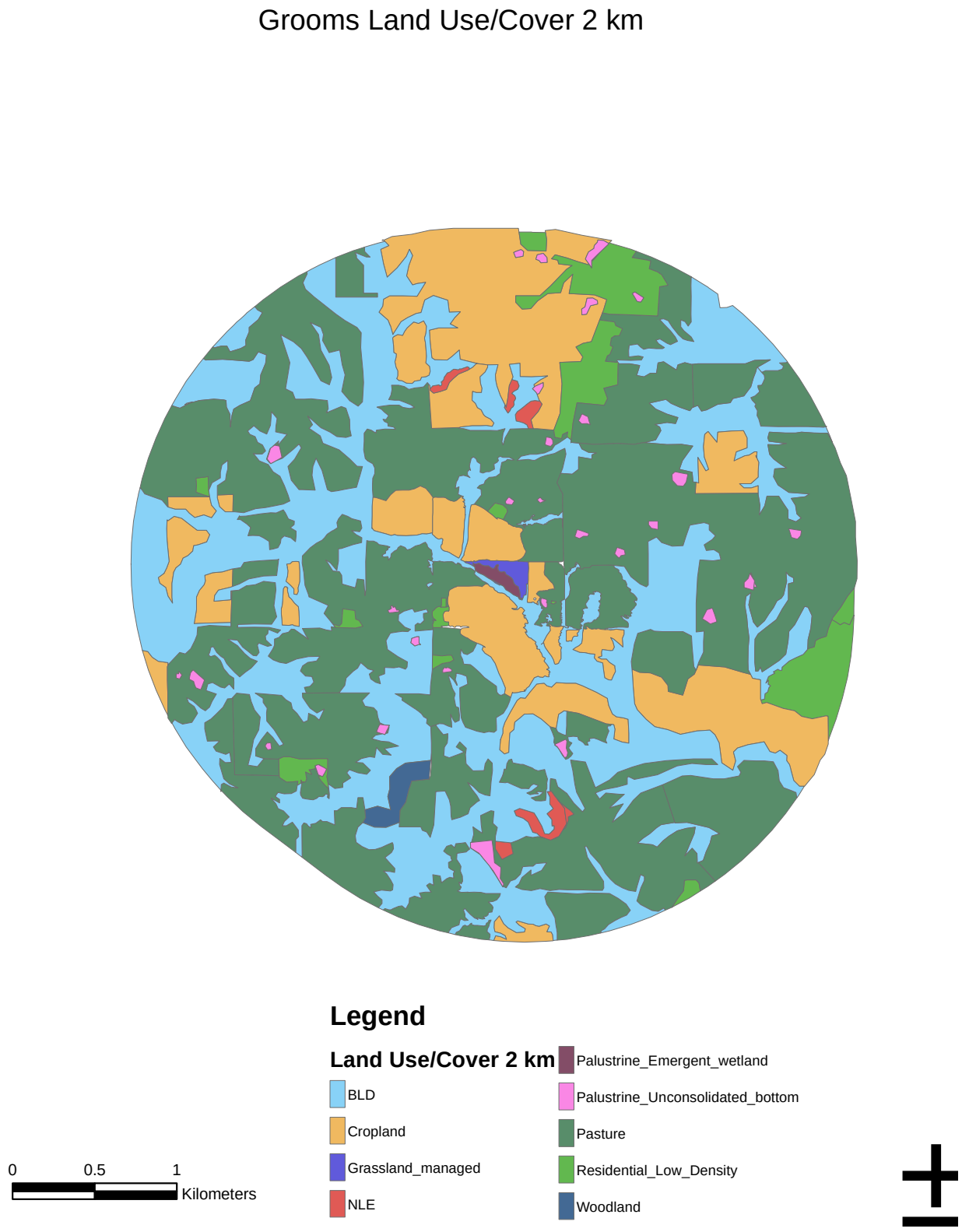


Figure 10 Grooms land use/cover within 2 km of the wetlands edge.

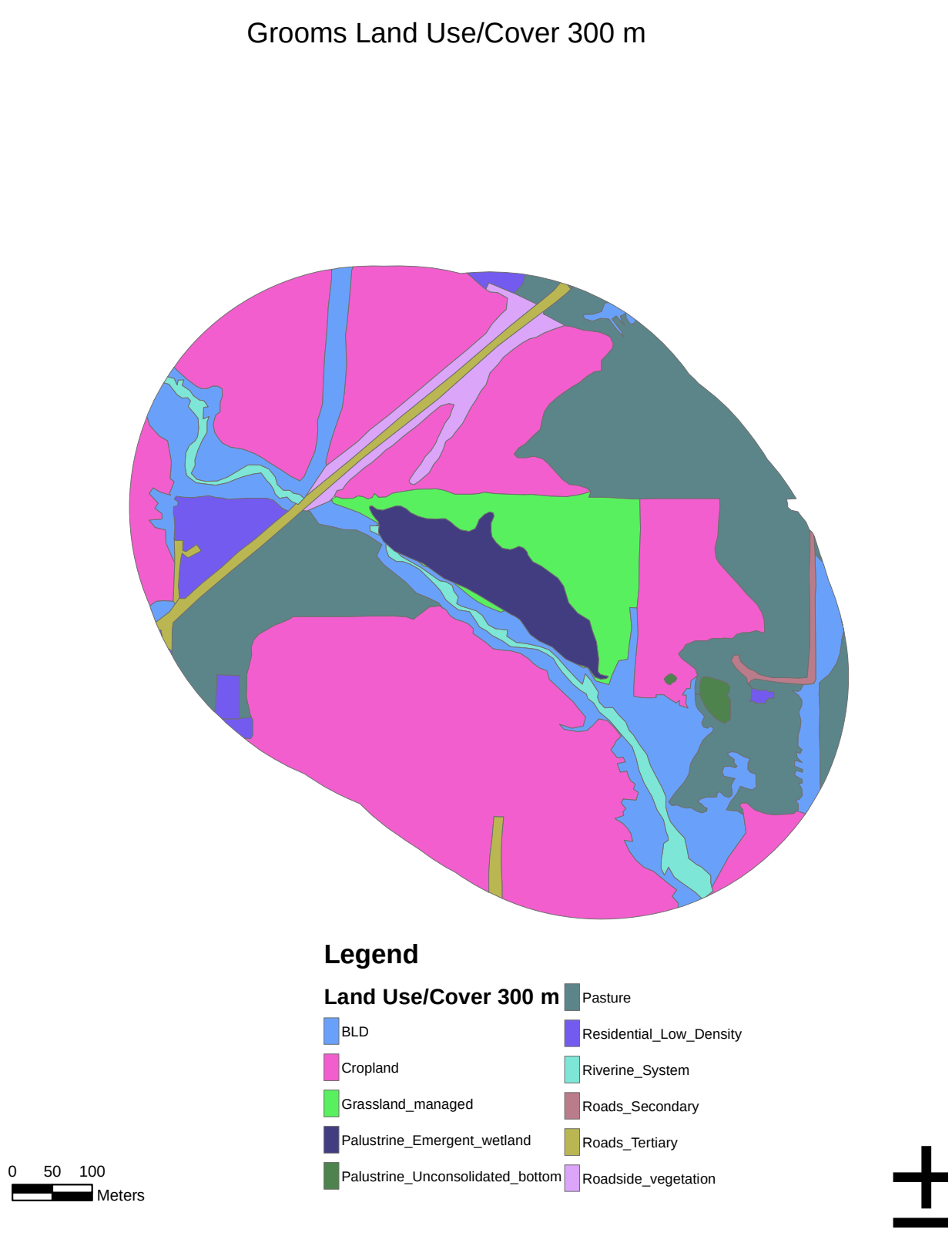


Figure 11 Grooms land use/cover within 300 m of the wetlands edge.

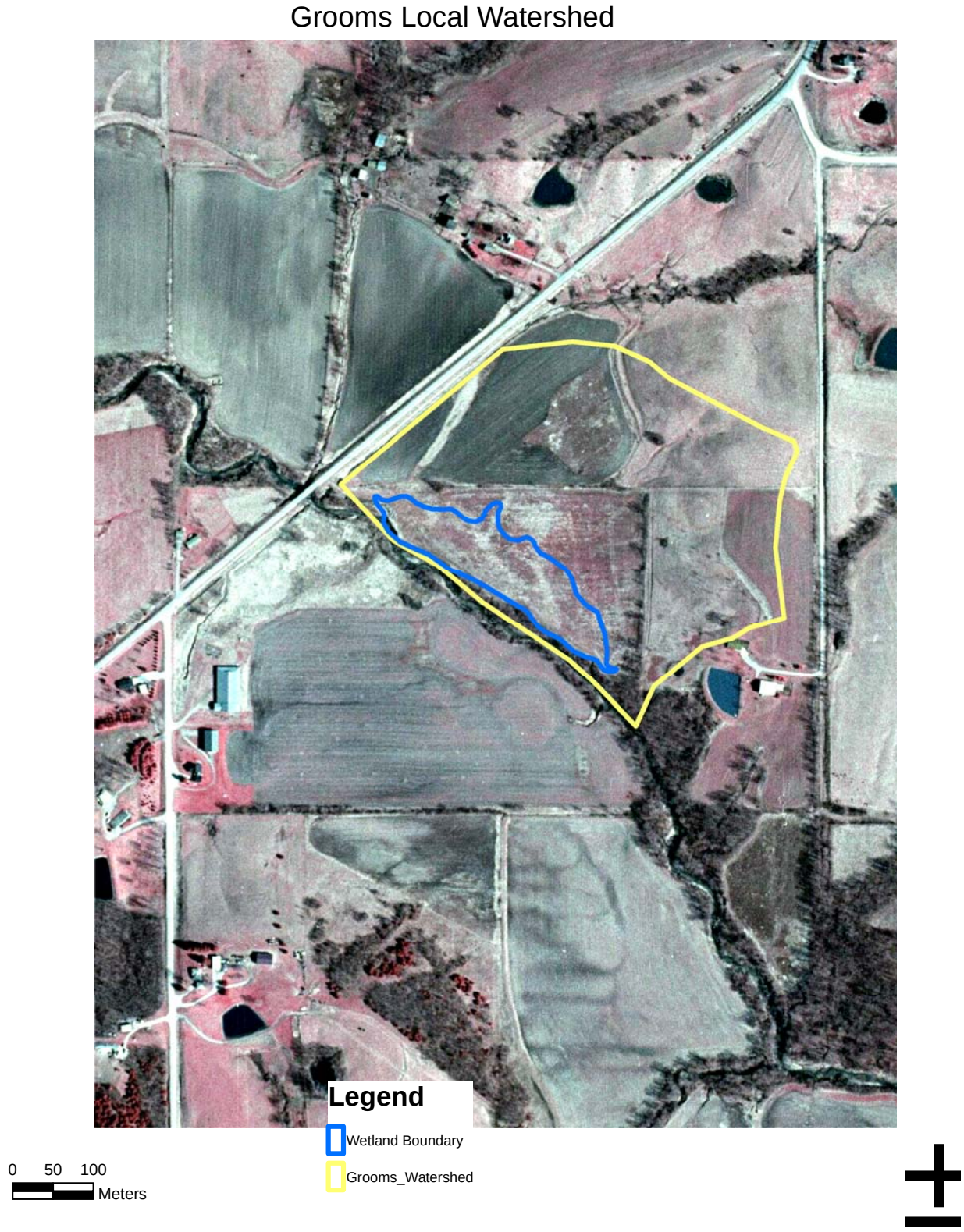


Figure 12 Grooms local watershed and wetland boundary.

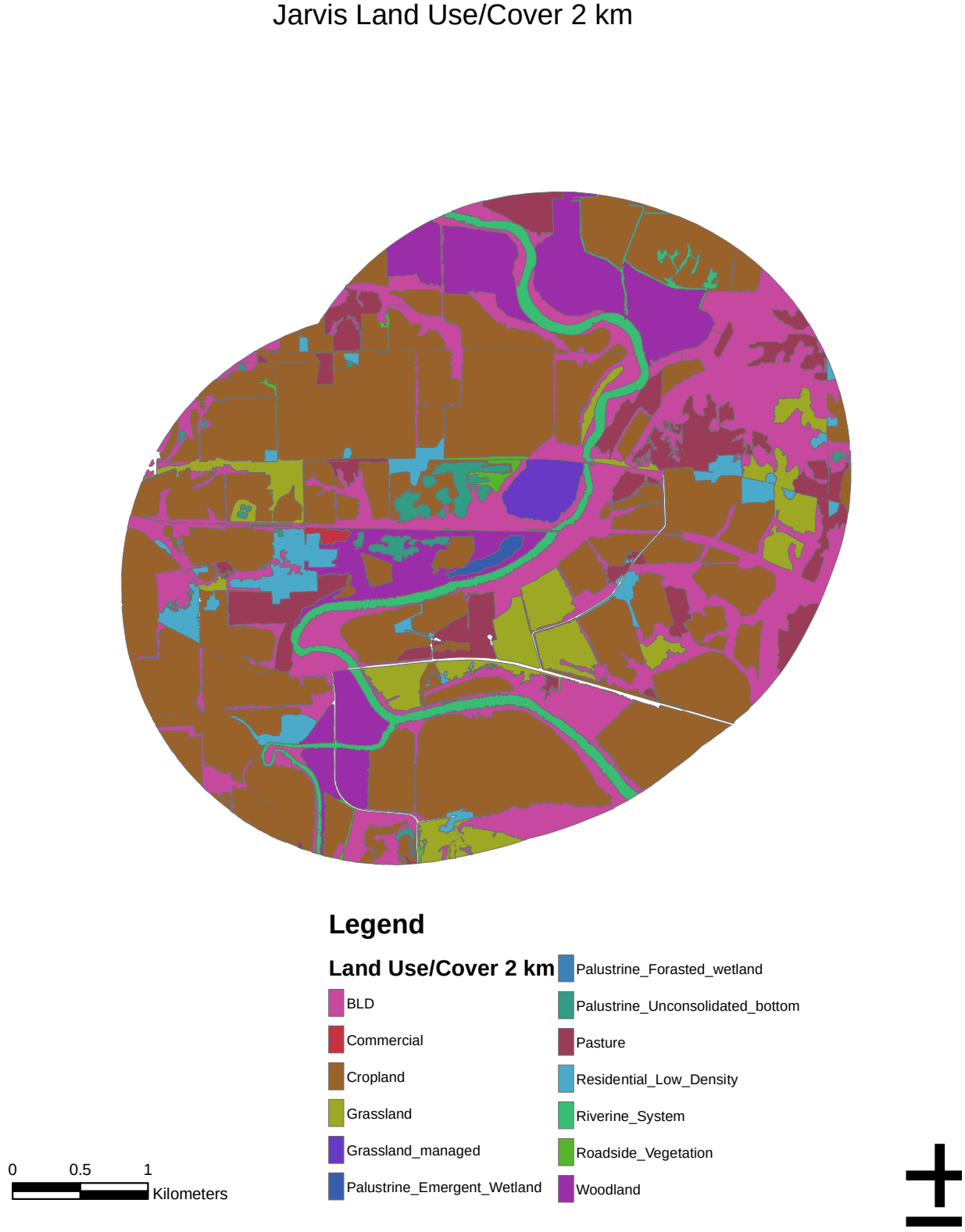


Figure 13 Jarvis land use/cover within 2 km of the wetlands edge.

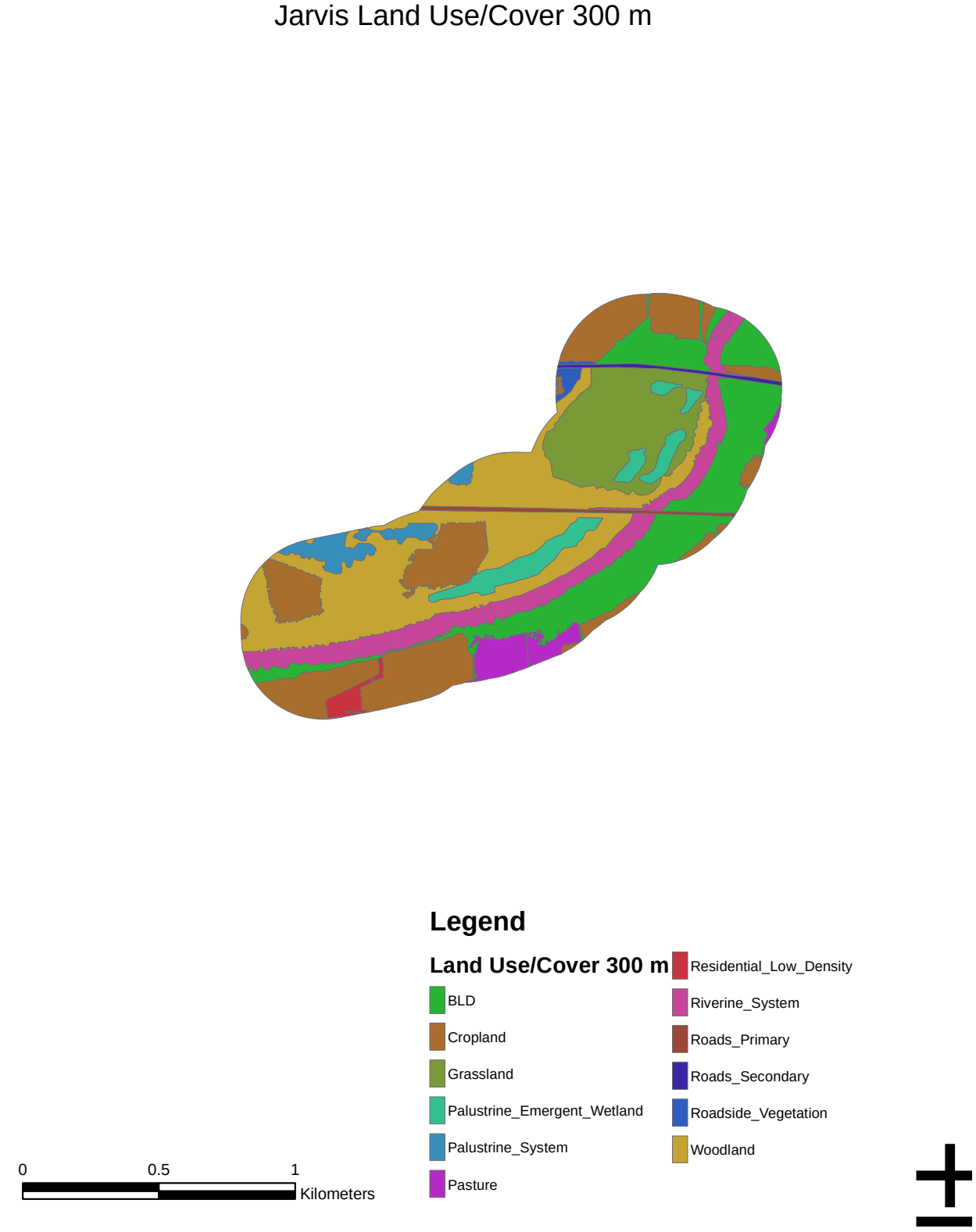


Figure 14 Jarvis land use/cover within 300 m of the wetlands edge.

Figure 15 Jarvis local watershed and wetland boundary.

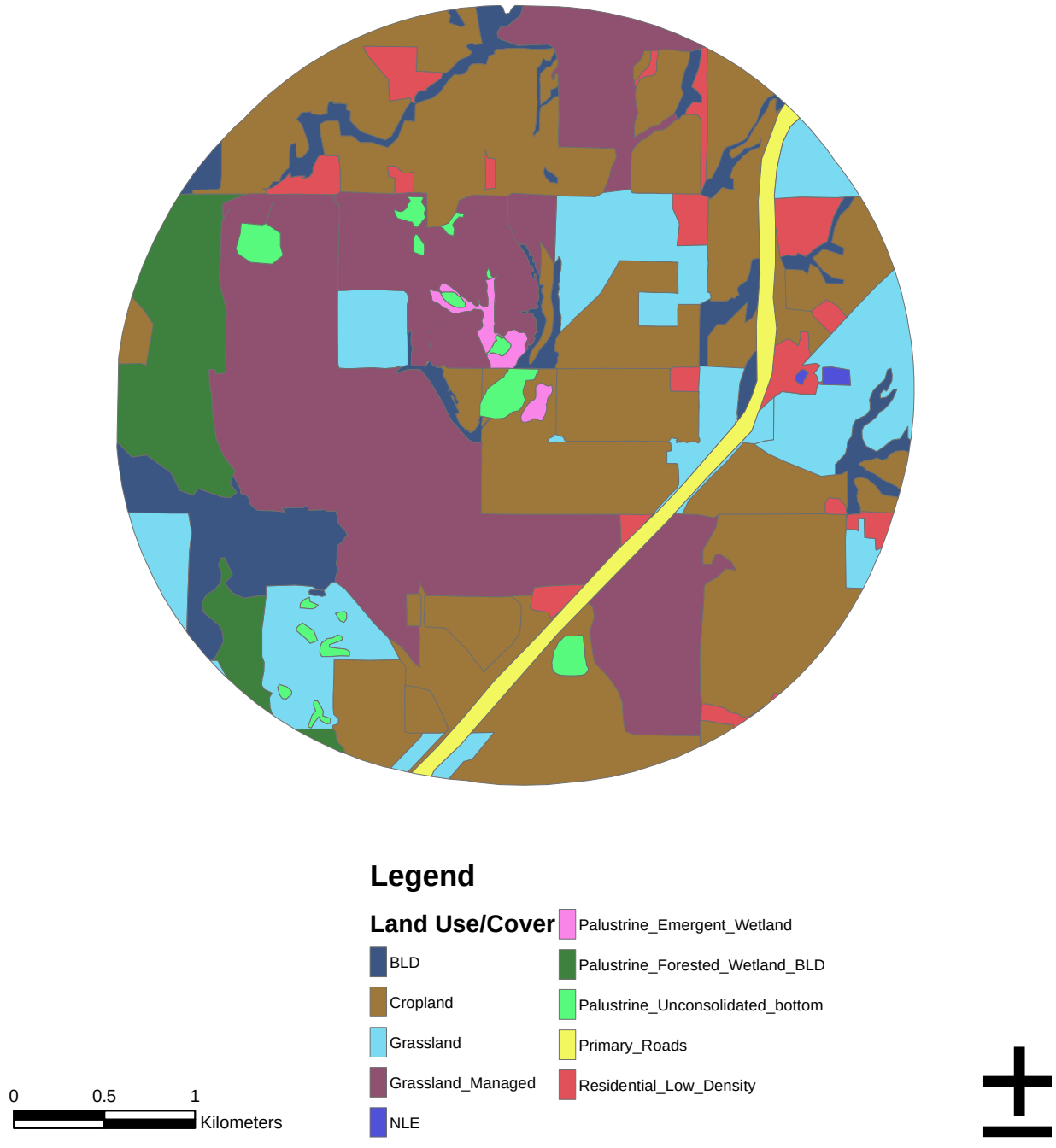
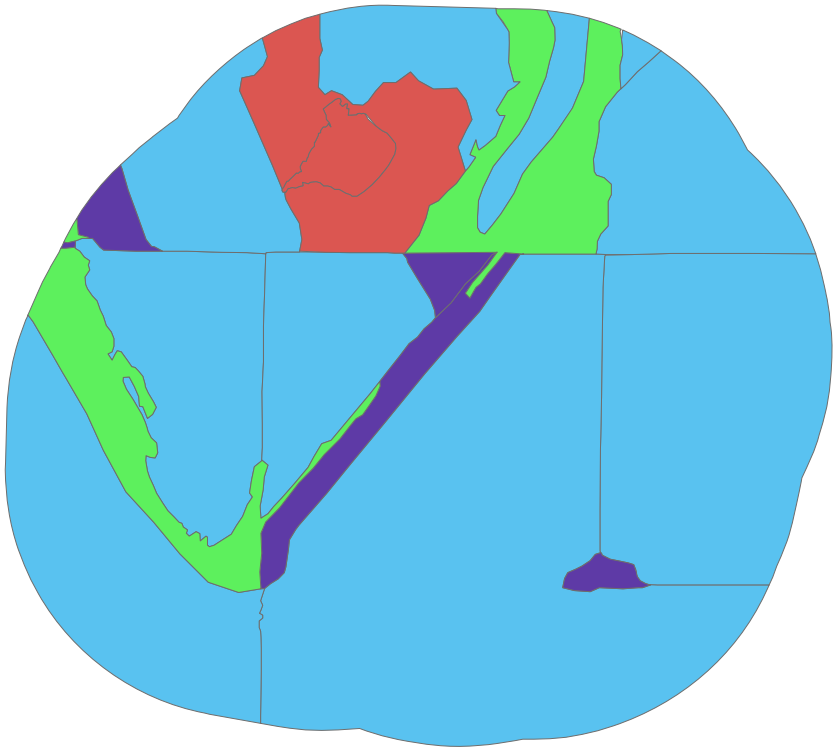


Figure 16 South Point land use/cover within 2 km of the wetlands edge.

South Point Land Use/Cover 300 m



Legend

Landclass_300m

Class_Name

- BLD
- Cropland
- Palustrine_System
- Pasture

0 50 100

Meters

Figure 17 South Point land use/cover within 300 m of the wetlands edge.

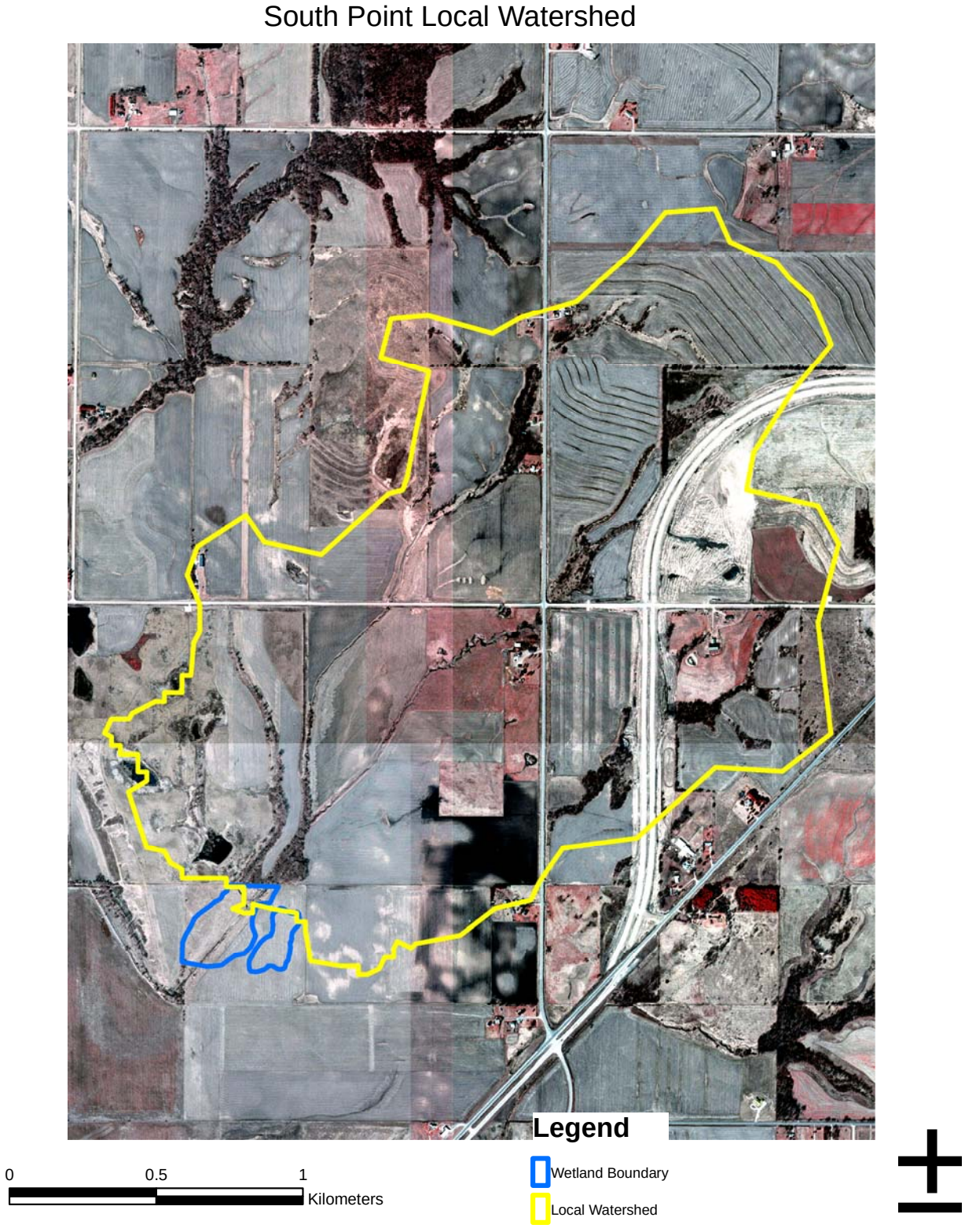
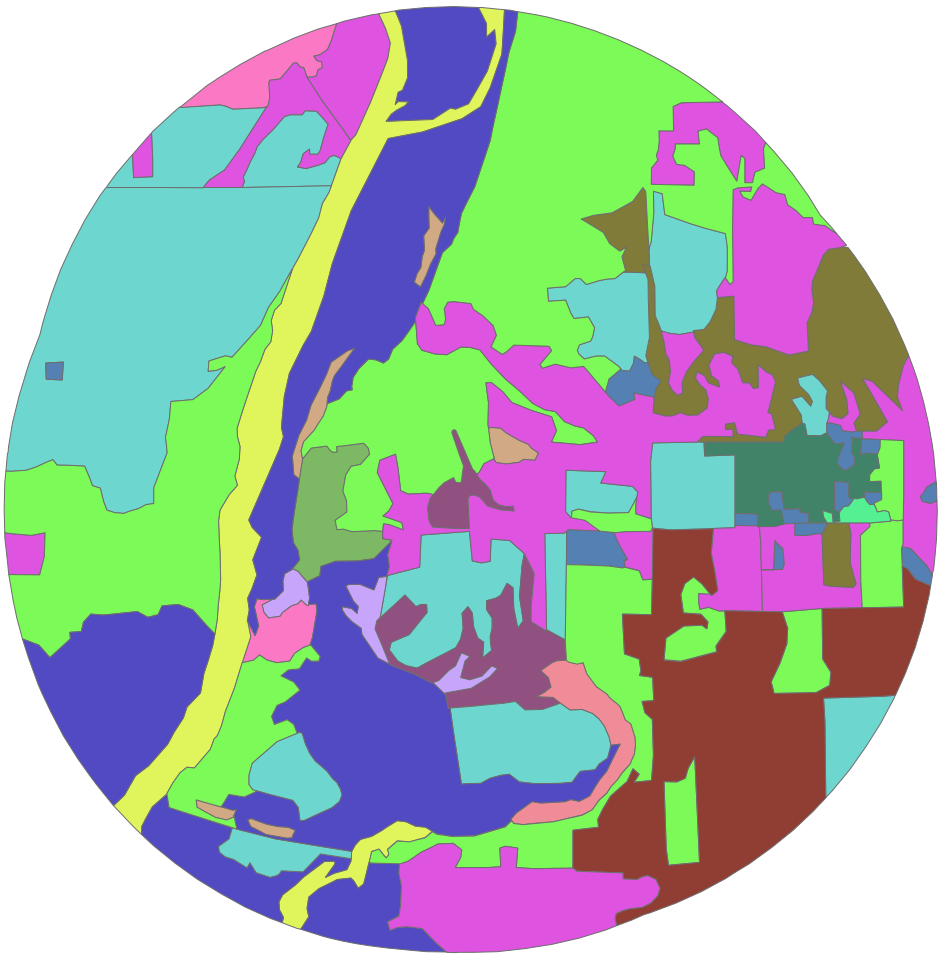


Figure 18 South Point local watershed and wetland boundary.

Wickiup Hill Land Use/Cover 2 km



0 0.5 1
Kilometers

Figure 19 Wickiup Hill land use/cover within 2 km of the wetlands edge.

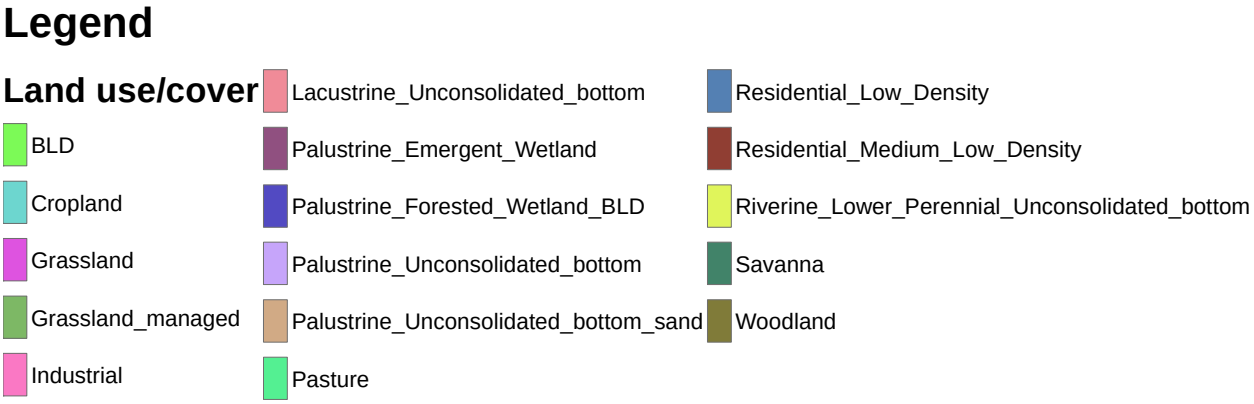


Figure 20 Wickiup Hill land use/cover within 2 km of the wetlands edge legend.

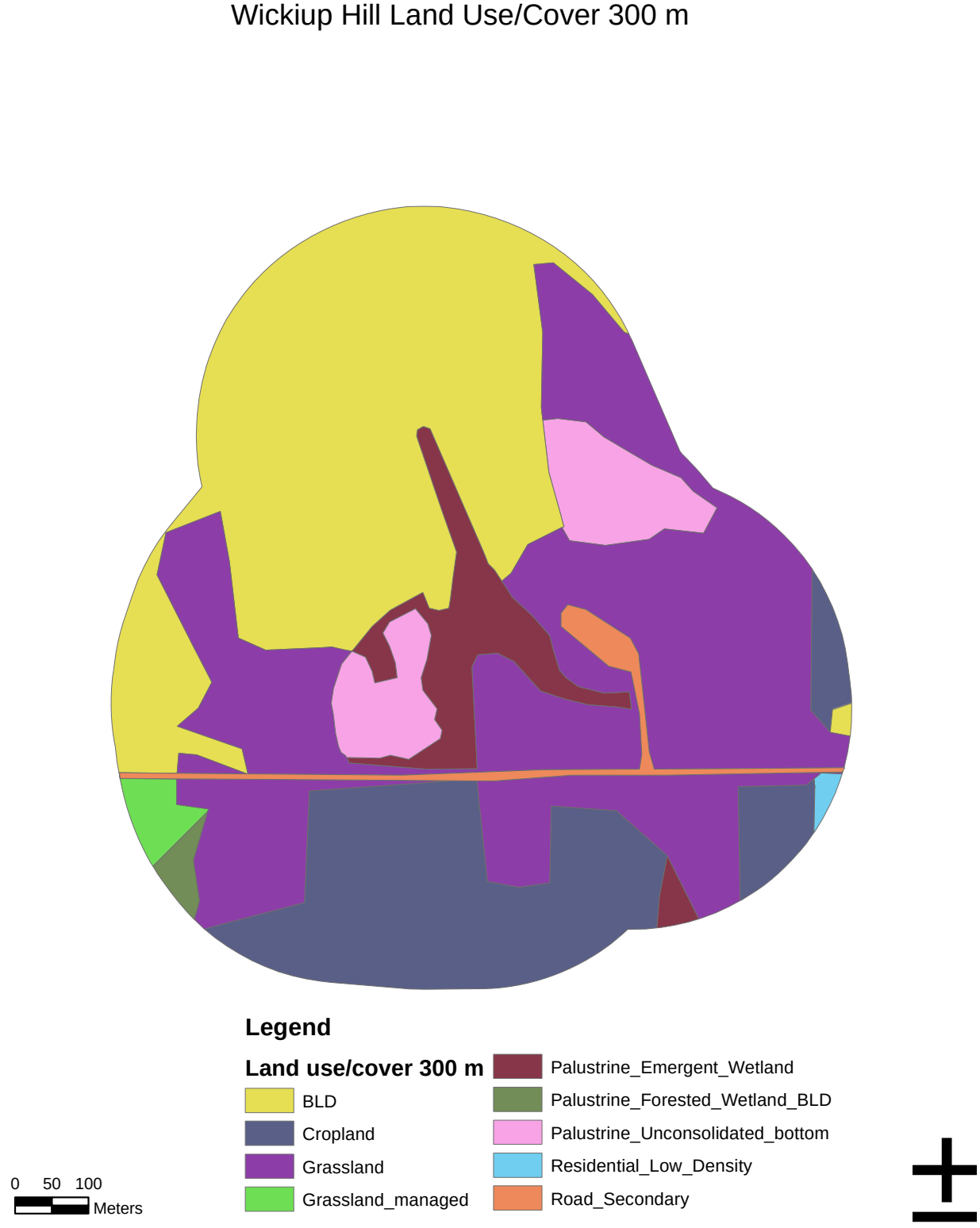


Figure 21 Wickiup Hill land use/cover within 300 m of the wetlands edge.

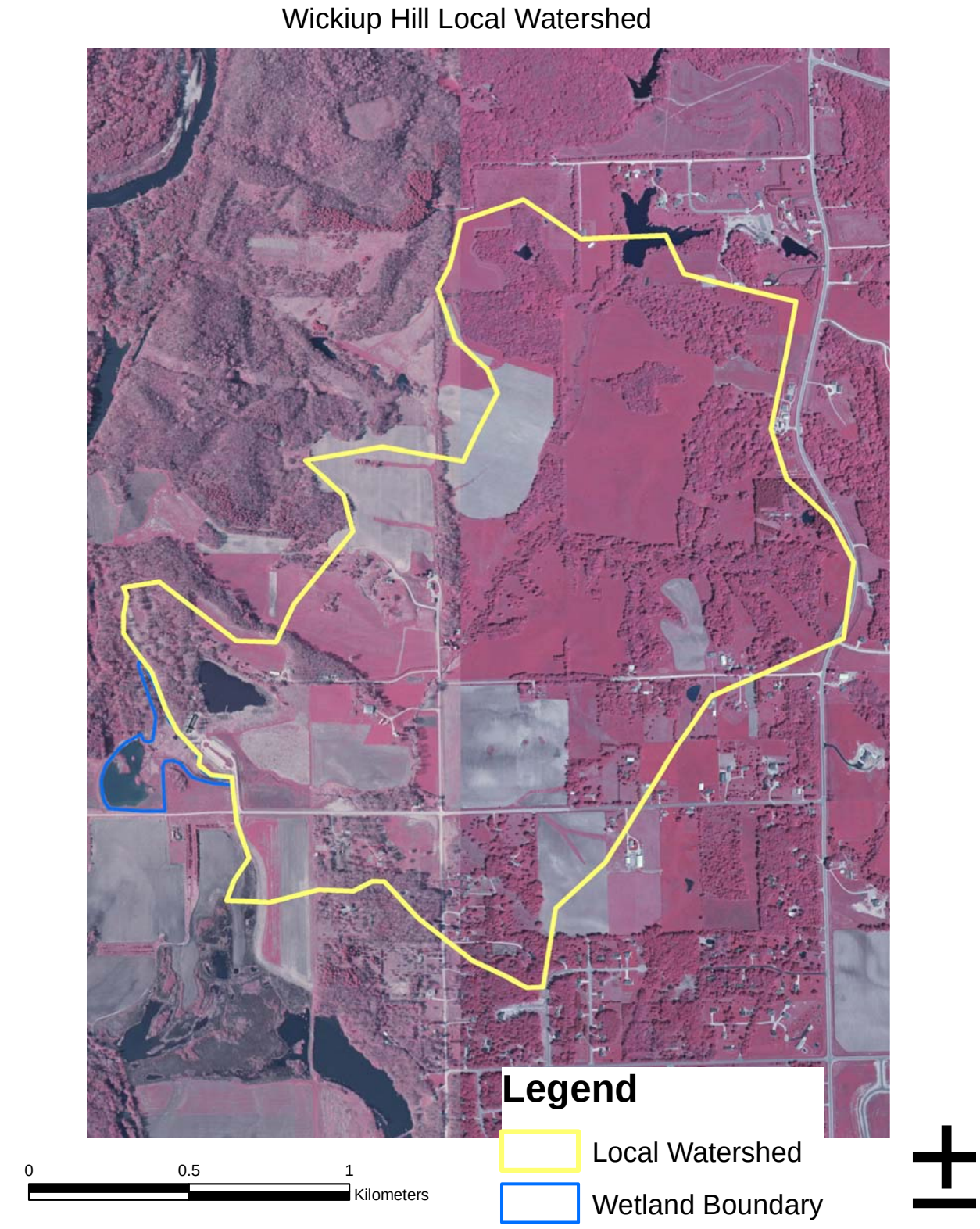


Figure 22 Wickiup Hill local watershed and wetland boundary.

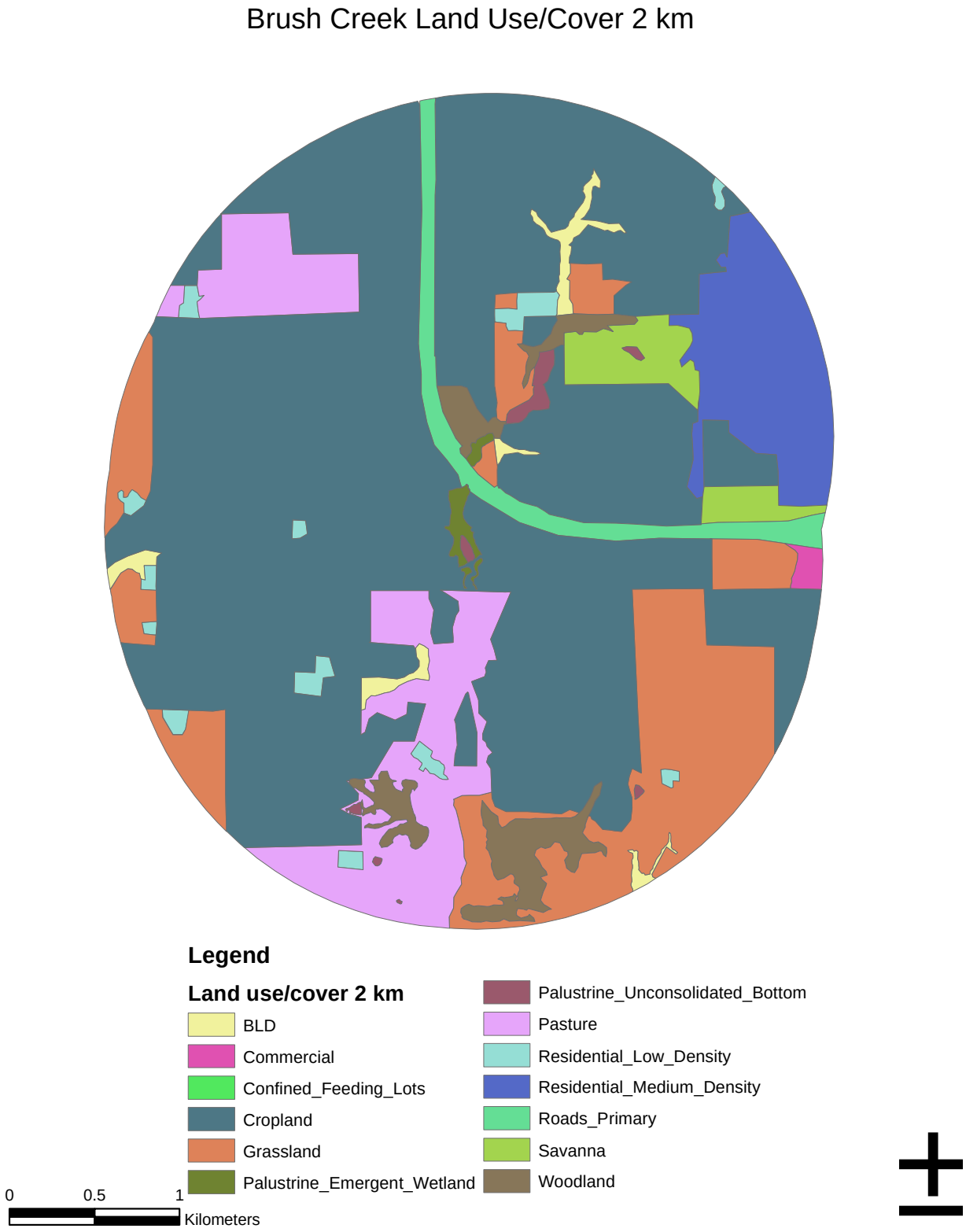


Figure 23 Brush Creek land use/cover within 2 km of the wetlands edge.

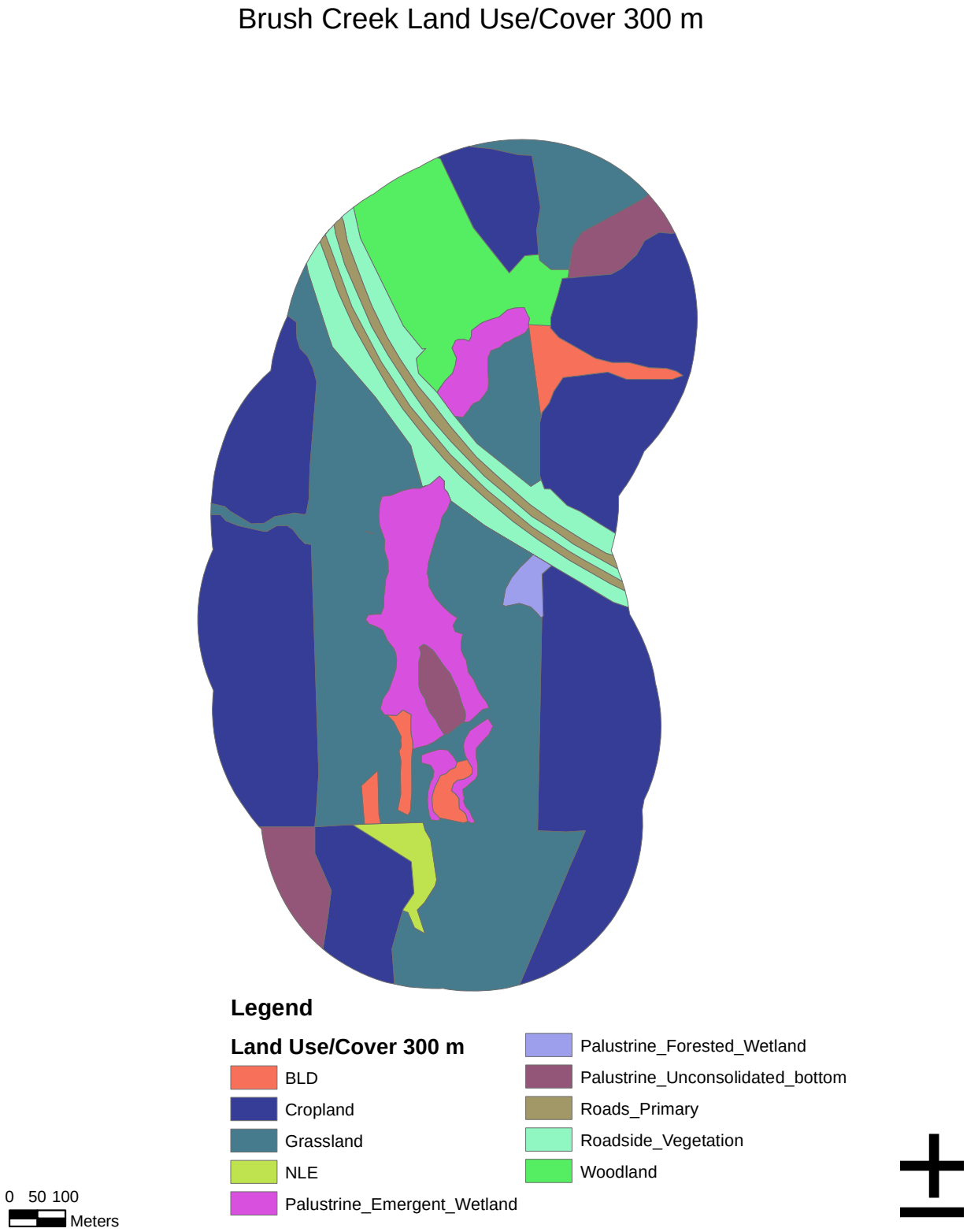


Figure 24 Brush Creek land use/cover within 300 m of the wetlands edge.

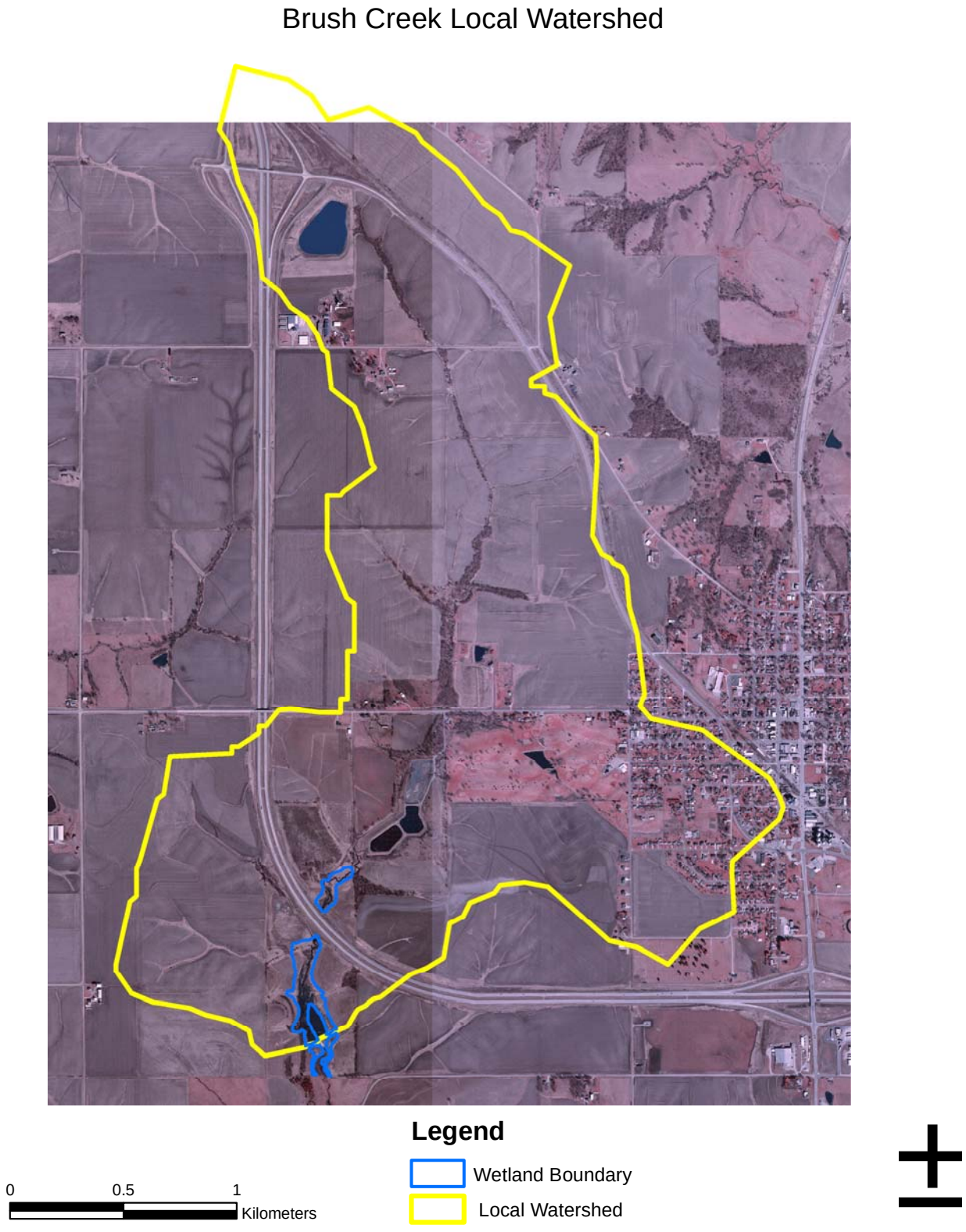


Figure 25 Brush Creek local watershed and wetland boundary.

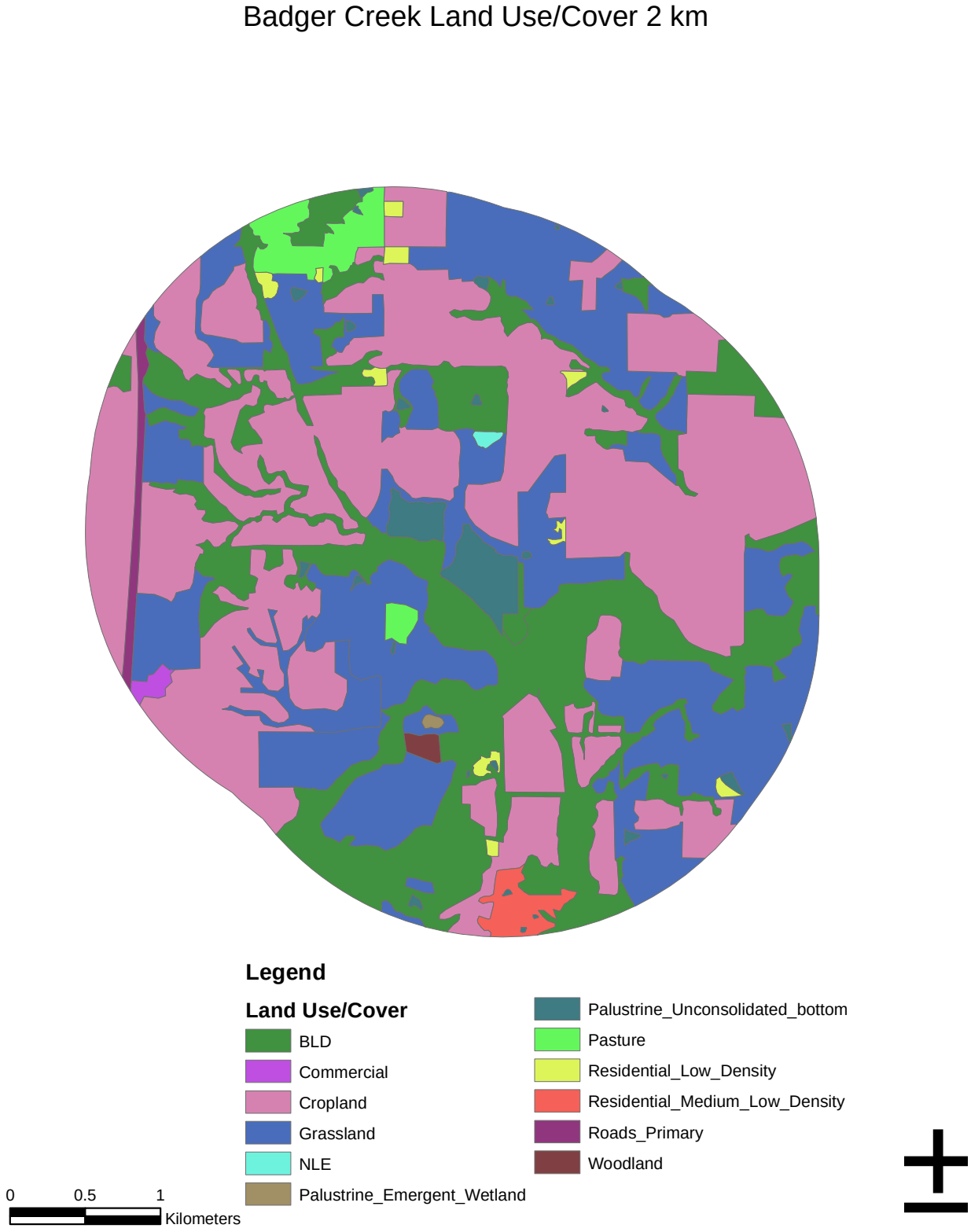


Figure 26 Badger Creek land use/cover within 2 km of the wetlands edge.

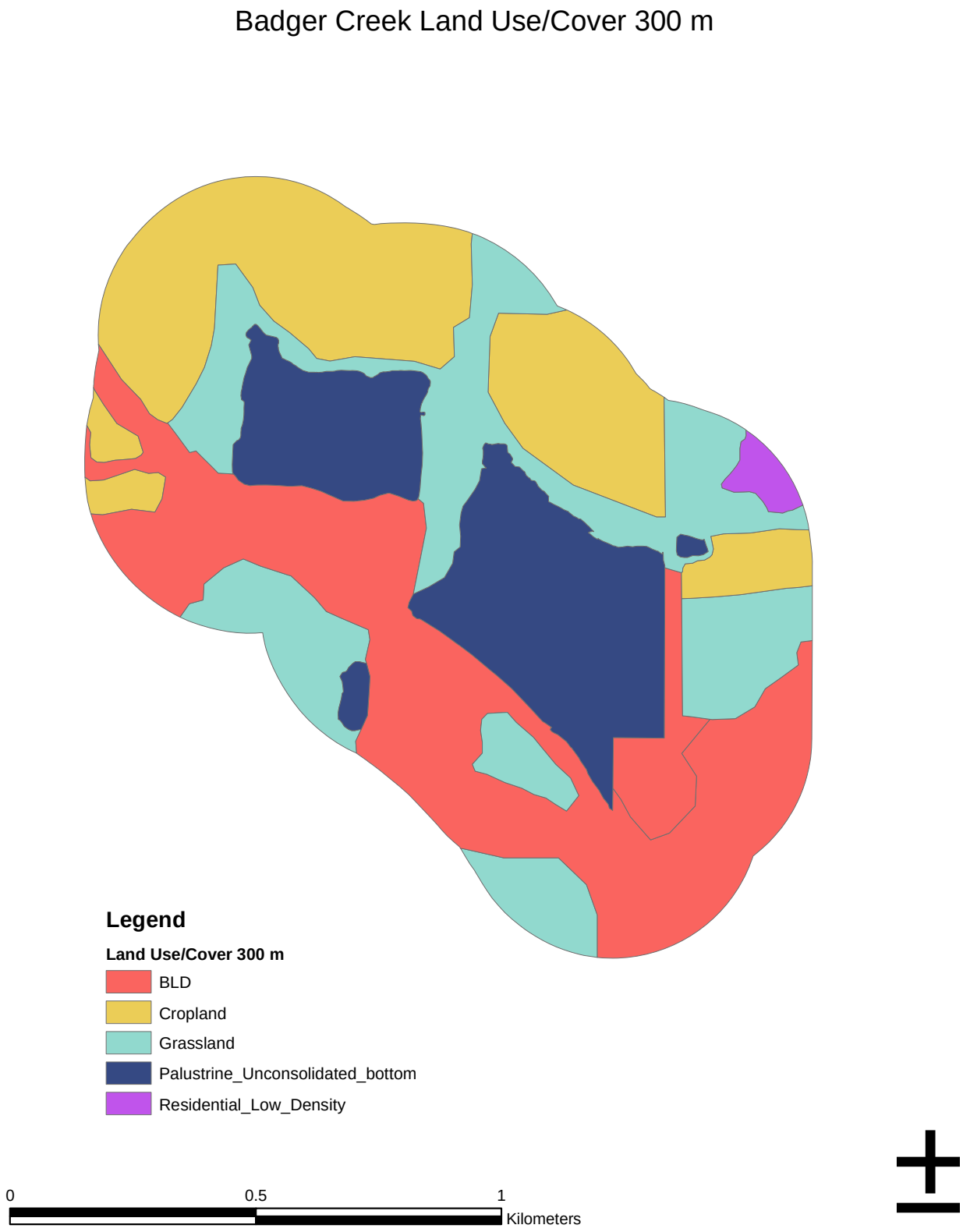


Figure 27 Badger Creek land use/cover within 300 m of the wetlands edge.

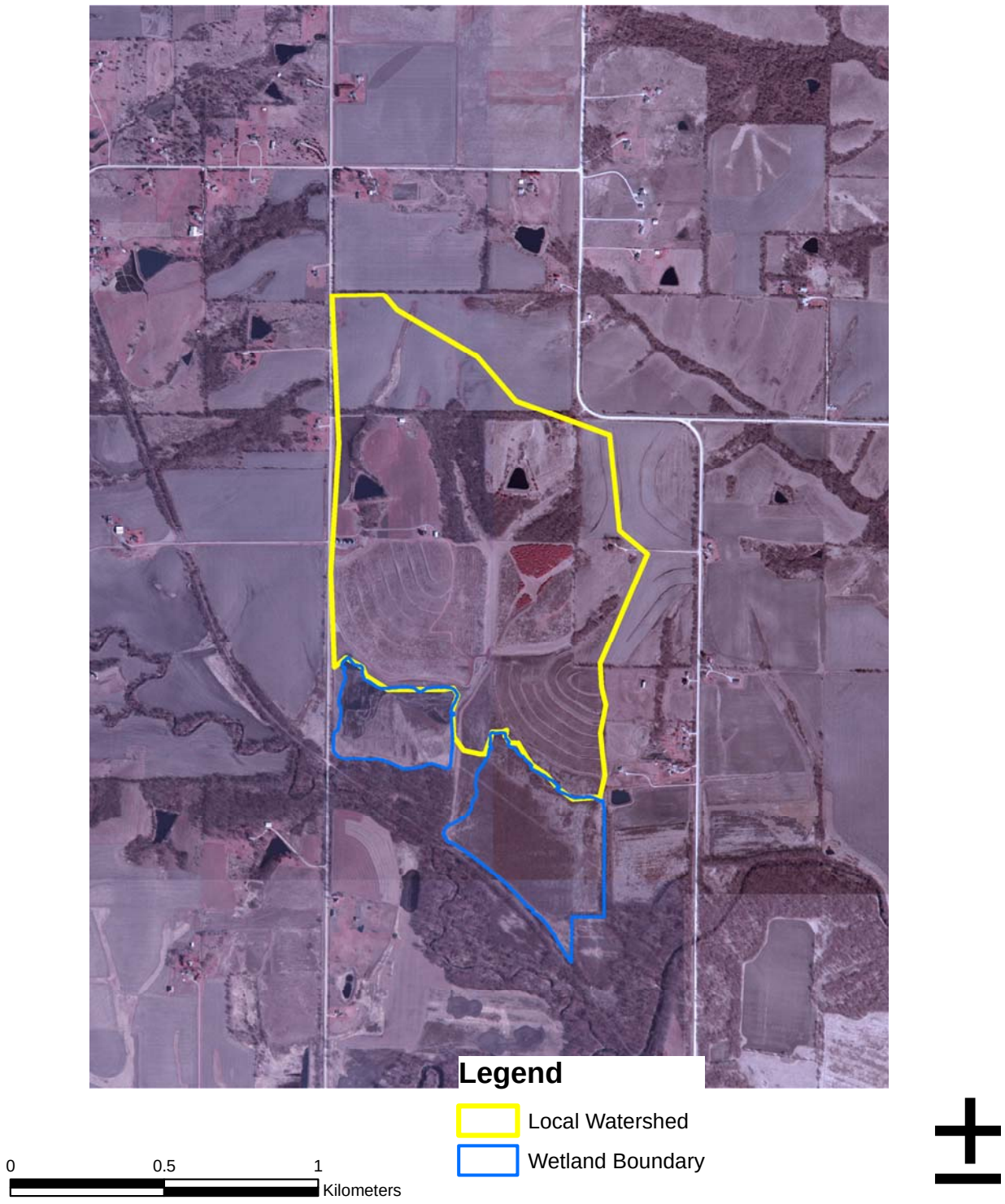


Figure 28 Badger Creek local watershed and wetland boundary.

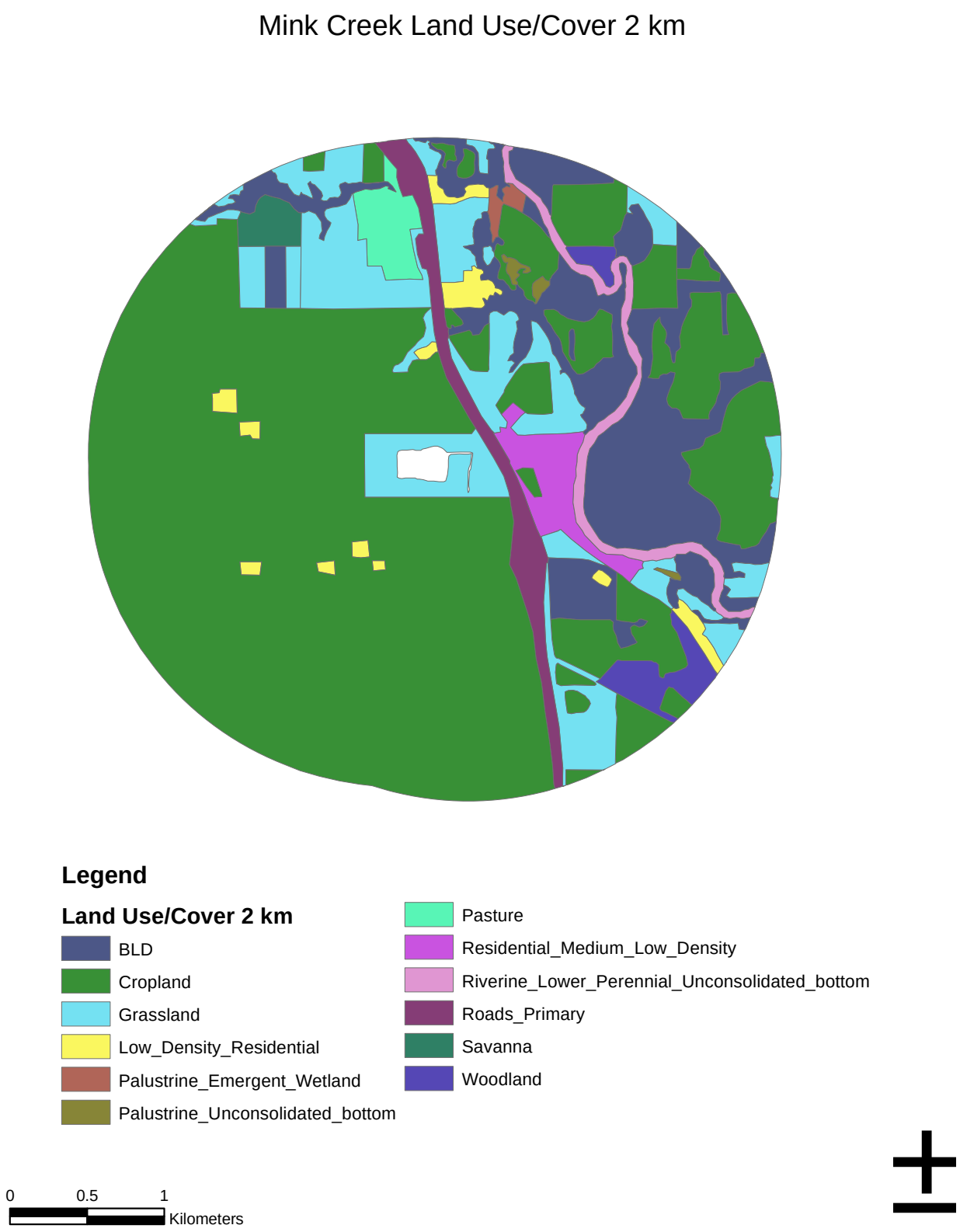
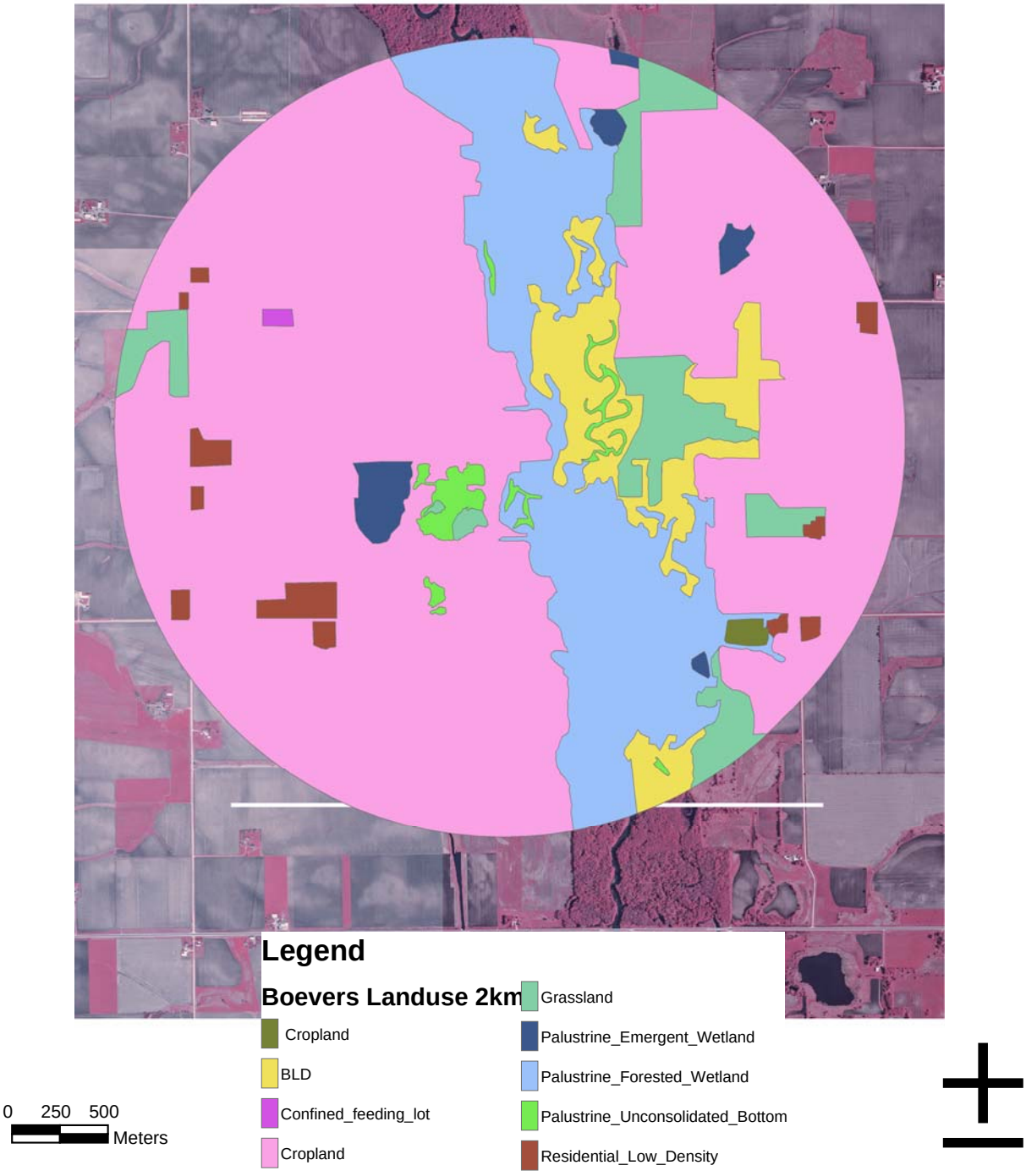


Figure 29 Mink Creek land use/cover within 2 km of the wetlands edge.

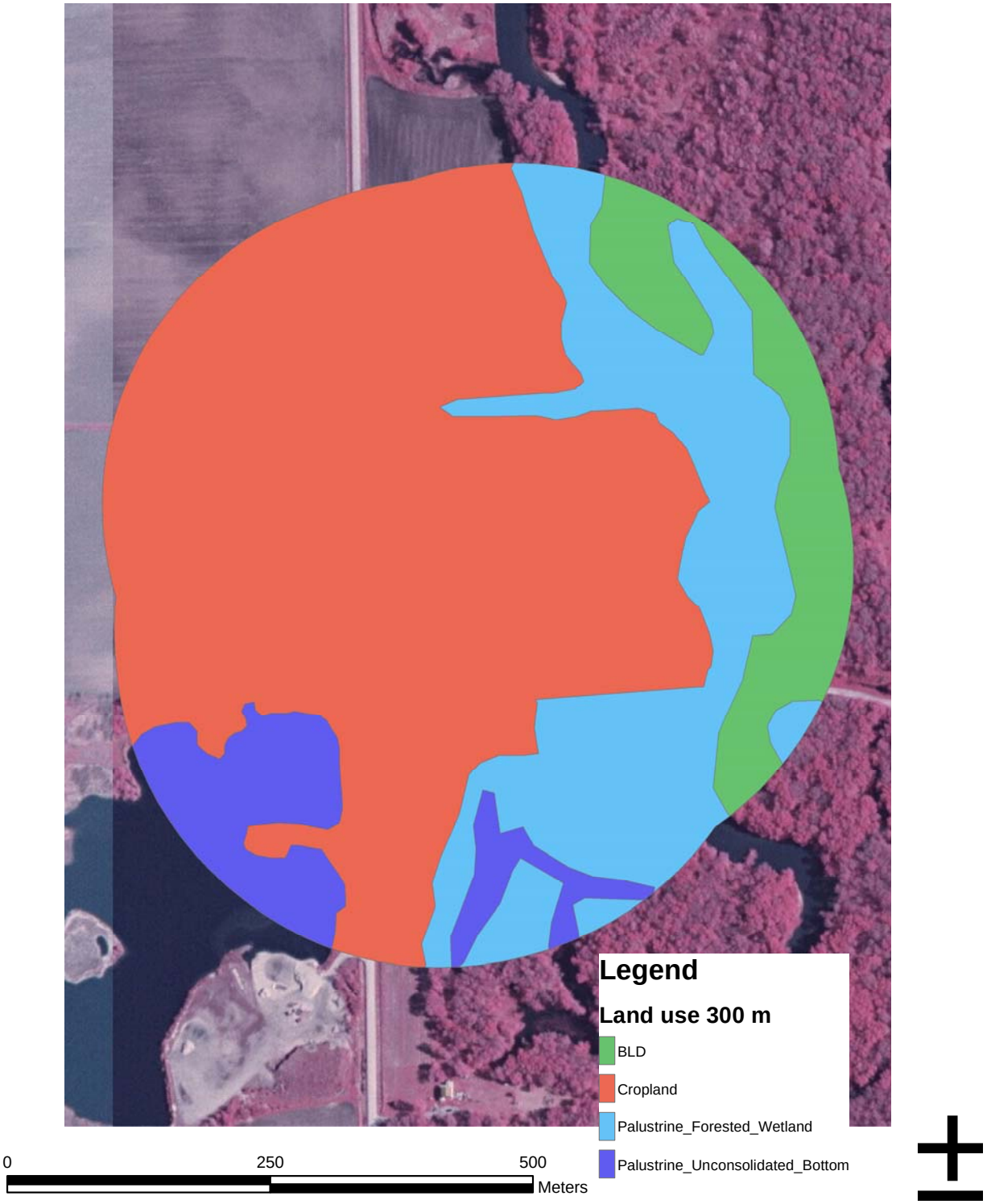
Figure 30 Mink Creek land use/cover within 300 m of the wetlands edge.

Figure 31 Mink Creek local watershed and wetland boundary.

Boevers Land Use/Cover 2 km

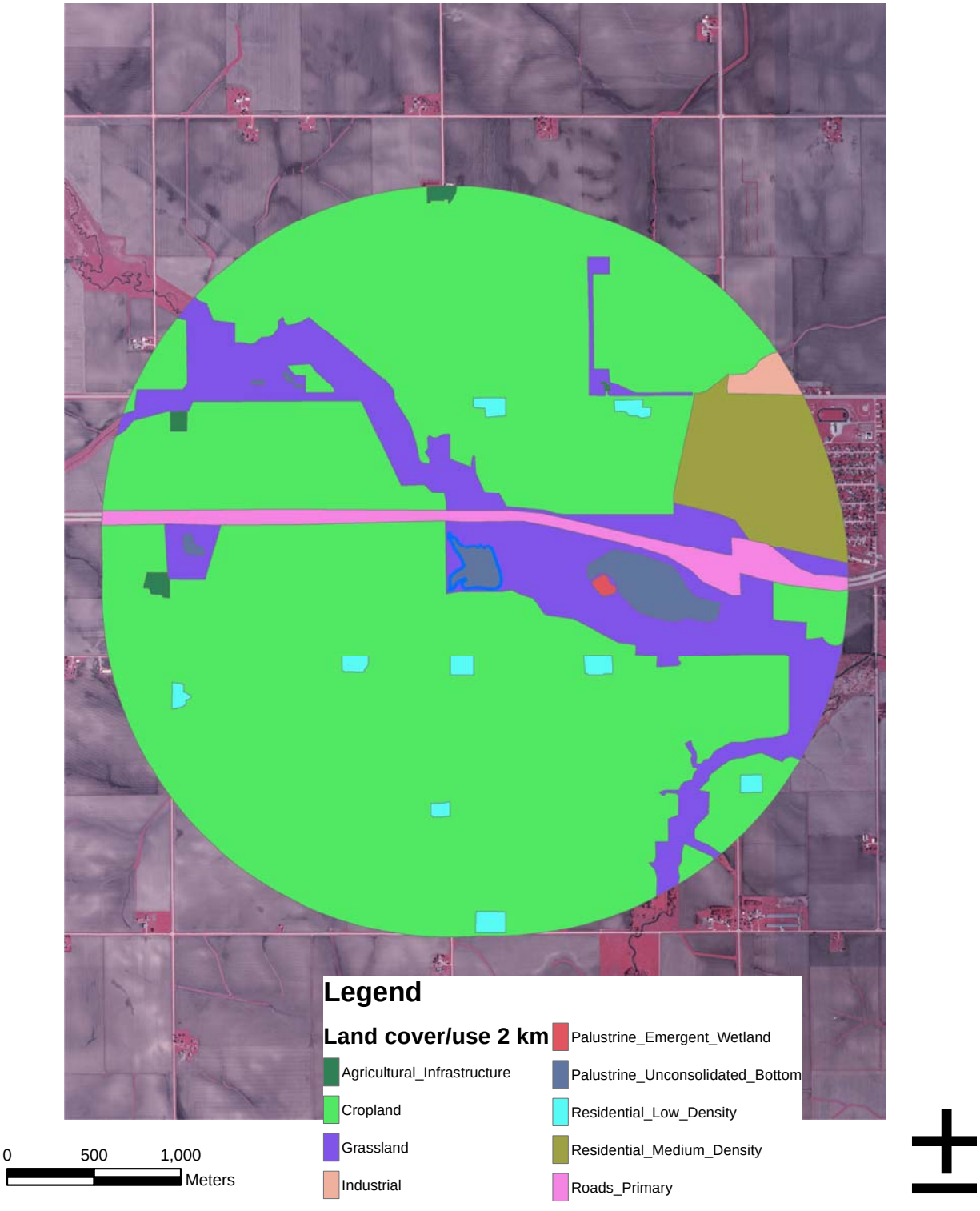


Boevers Land Use/Cover 300 m

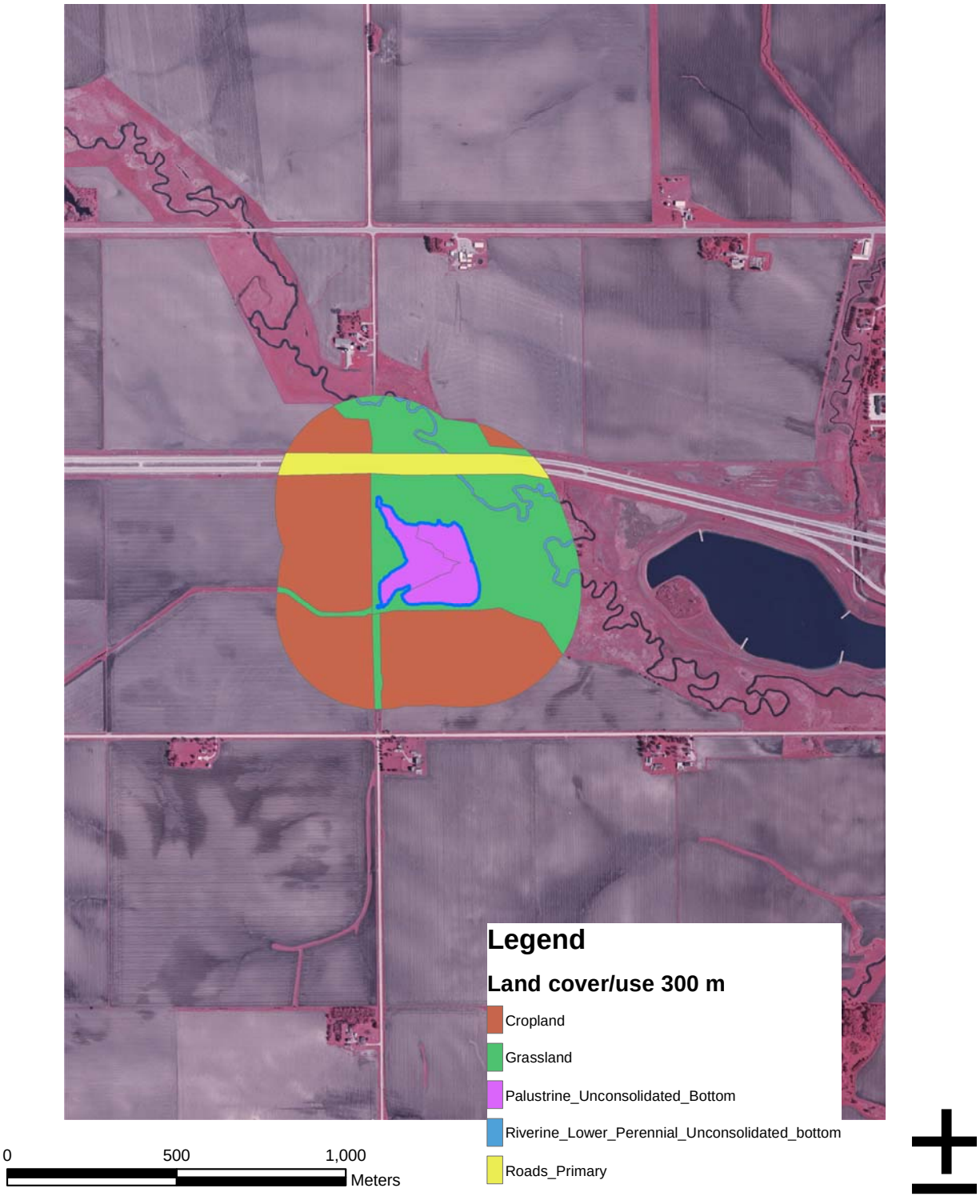


Boevers Local Watershed

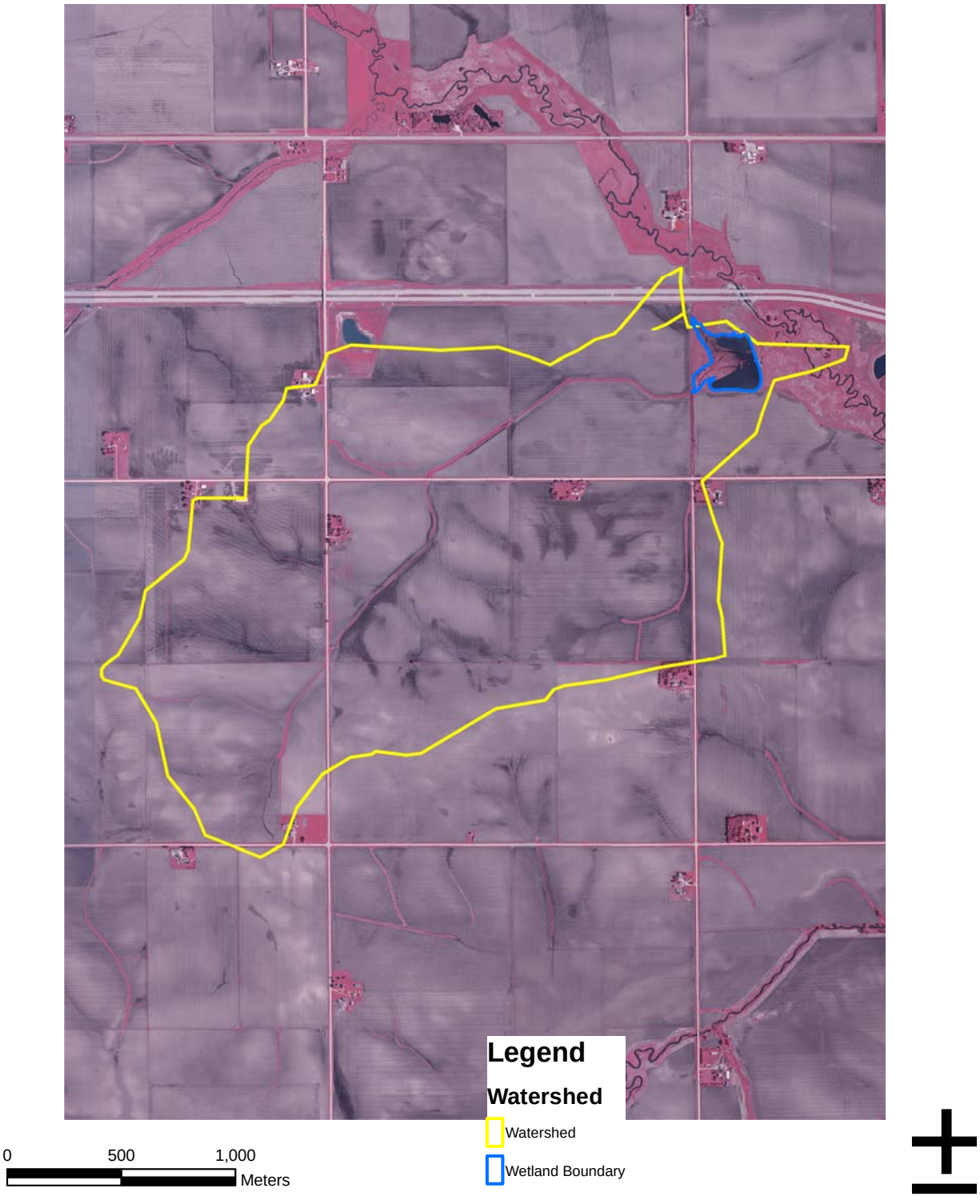
Dike Land Use/Cover 2 km



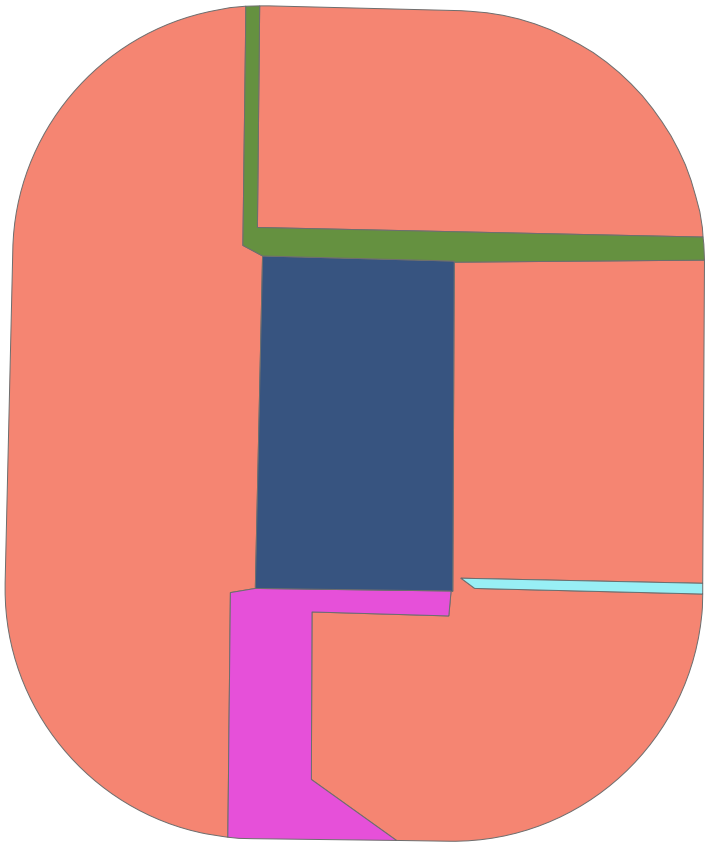
Dike Land Use/Cover 300 m



Dike Local Watershed



Doolittle Land use/cover 300 m



Legend

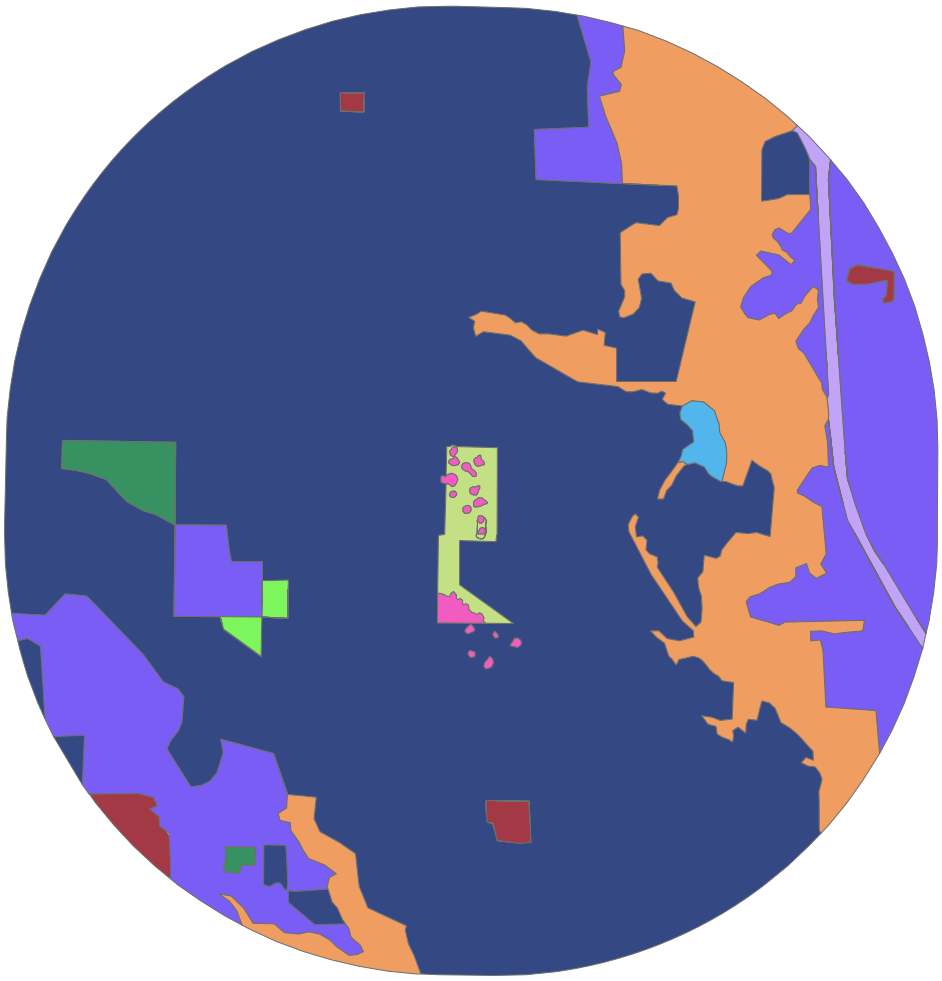
Land cover/use 300 m

- Cropland
- Grassland
- Grassland_managed
- Palustrine_Emergent_Wetland
- Road_Side_Vegetation

0 250 500

Meters

Doolittle Land Use/Cover 2 km



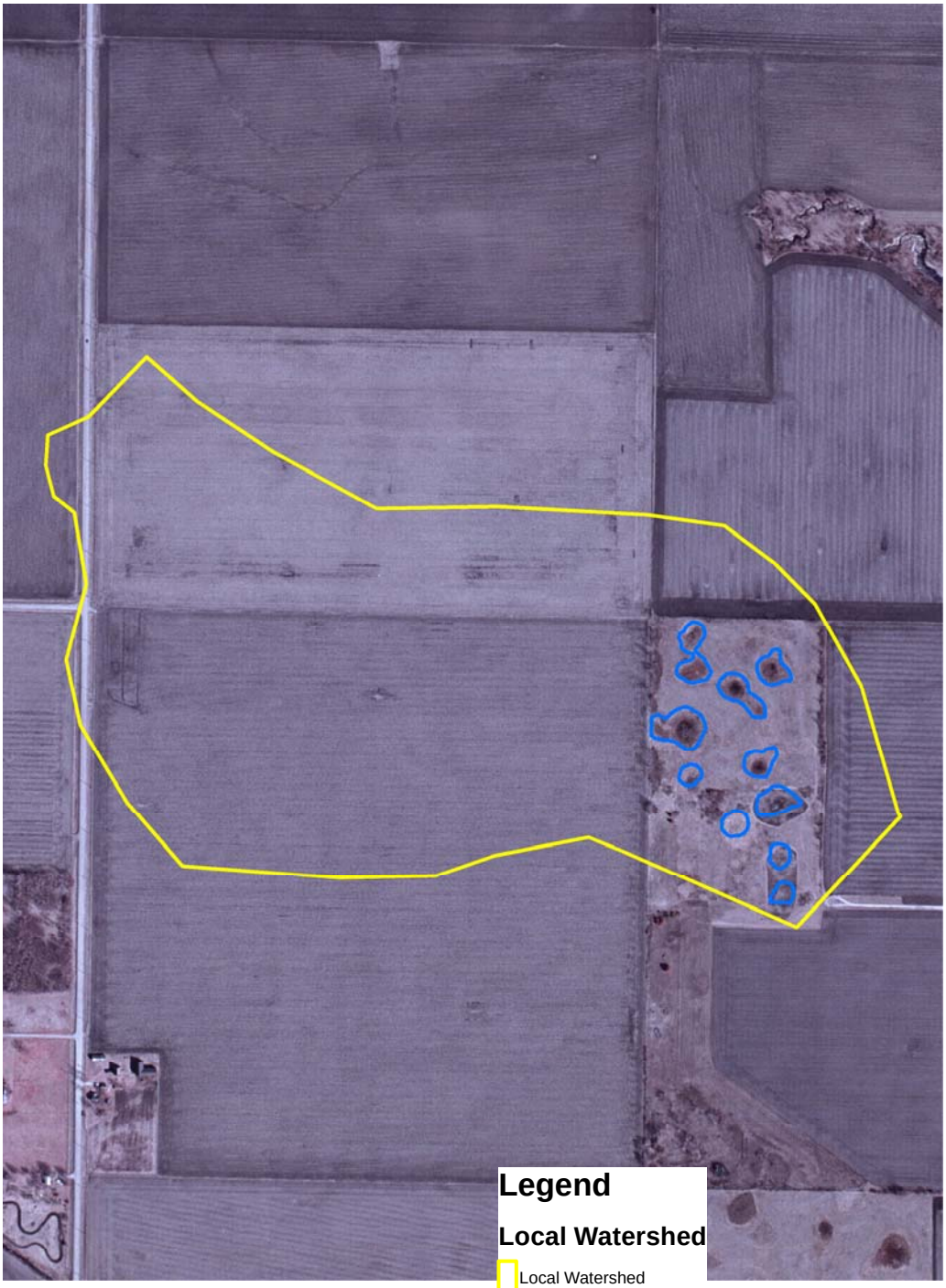
Legend

Land use/cover 2 km

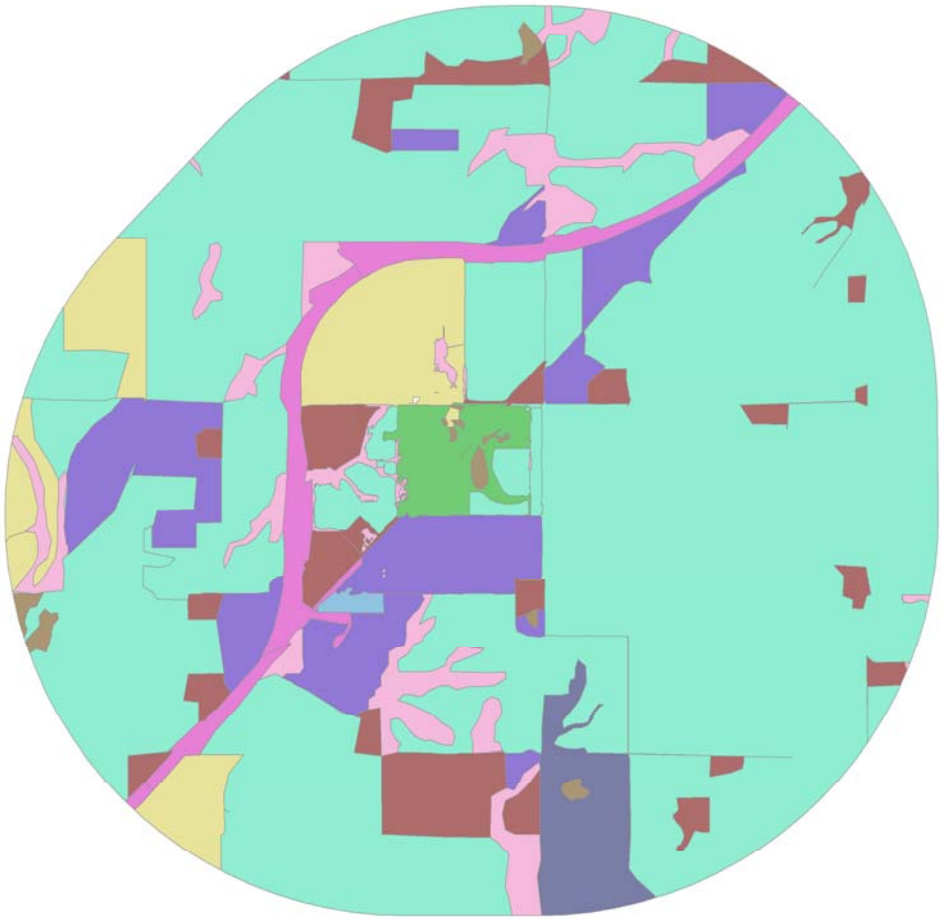
- BLD
- Confined_Feeding_Lot
- Cropland
- Grassland
- Grassland_managed
- Industrial
- Palustrine_Emergent_Wetland
- Residential_Low_Density
- Residential_Medium_Low_Density
- Roads_Primary

0 500 1,000 Meters

Doolittle Local Watershed



Engeldinger Land Use/Cover 2 km



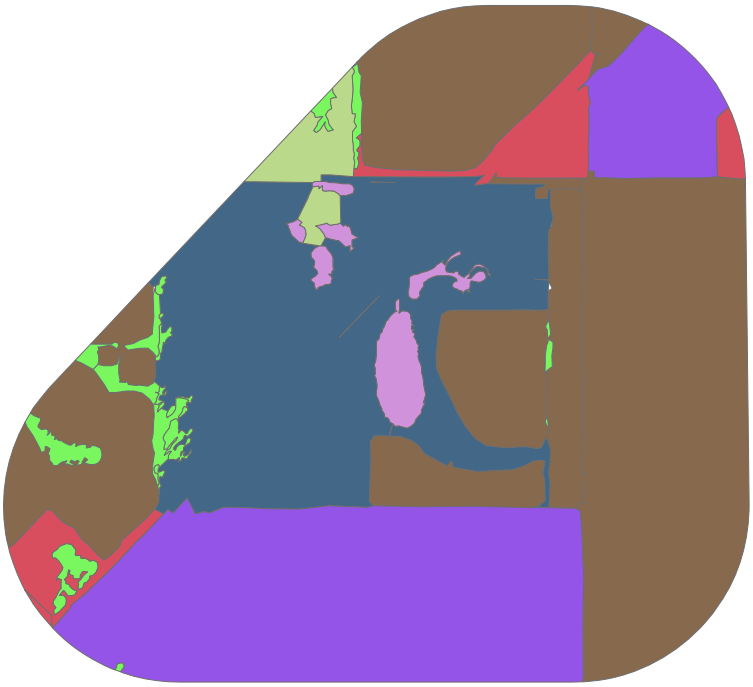
Legend

Land use/cover 2 km

- BLD
- Cropland
- Grassland
- Grassland_managed
- NLE
- Palustrine_Emergent_Wetland
- Palustrine_Unconsolidated_bottom
- Residential_Low_Density
- Roads_Primary
- Savanna

0 500 1,000
Meters

Engeldinger Land Use/Cover 300 m



Legend

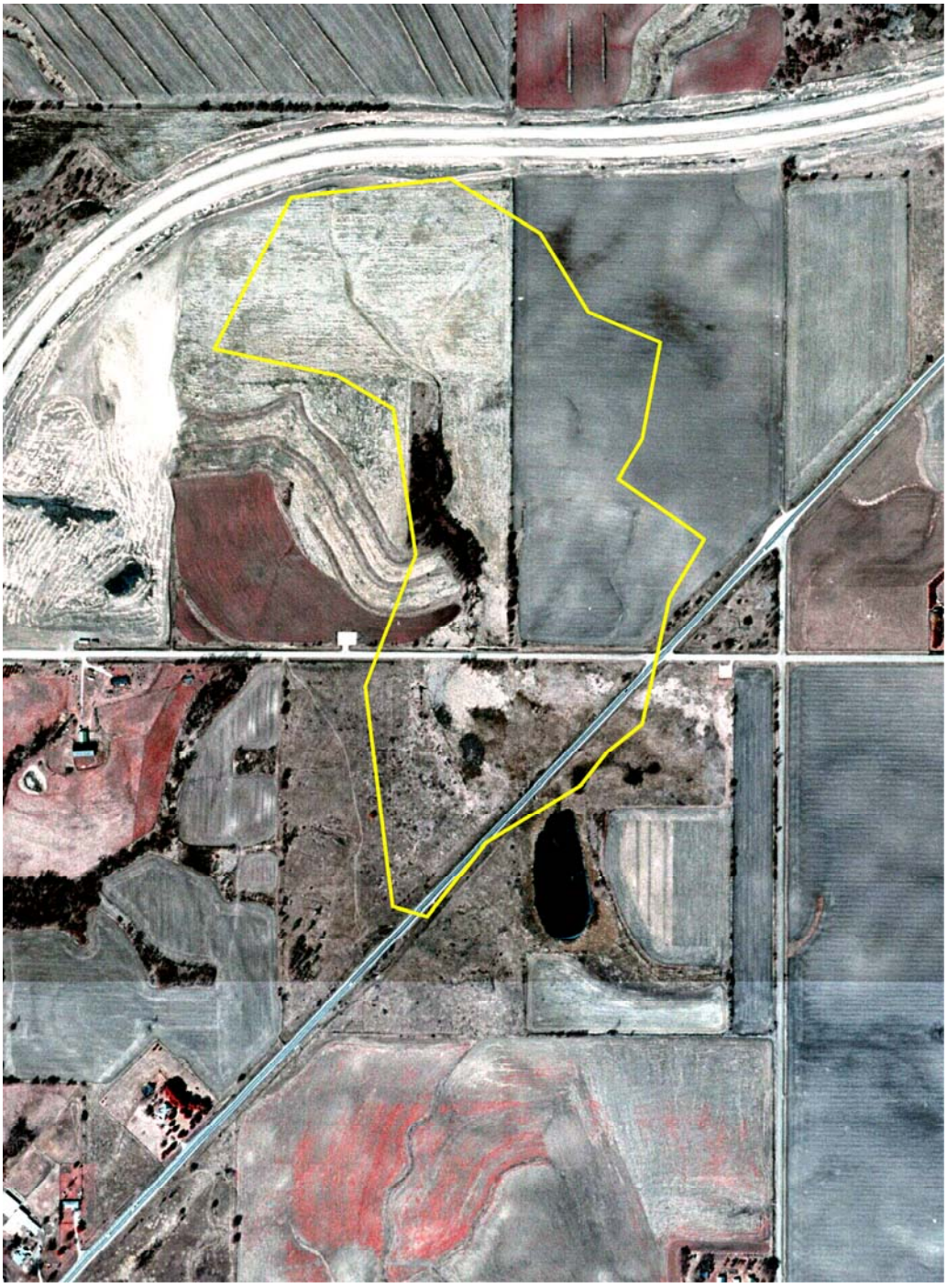
Land use/cover 300 m

- BLD
- Cropland
- Grassland
- Grassland_managed
- Palustrine_Emergent_Wetland
- Palustrine_Unconsolidated_bottom
- Residential_Low_Density

0 250 500

Meters

Engeldinger Local Watershed

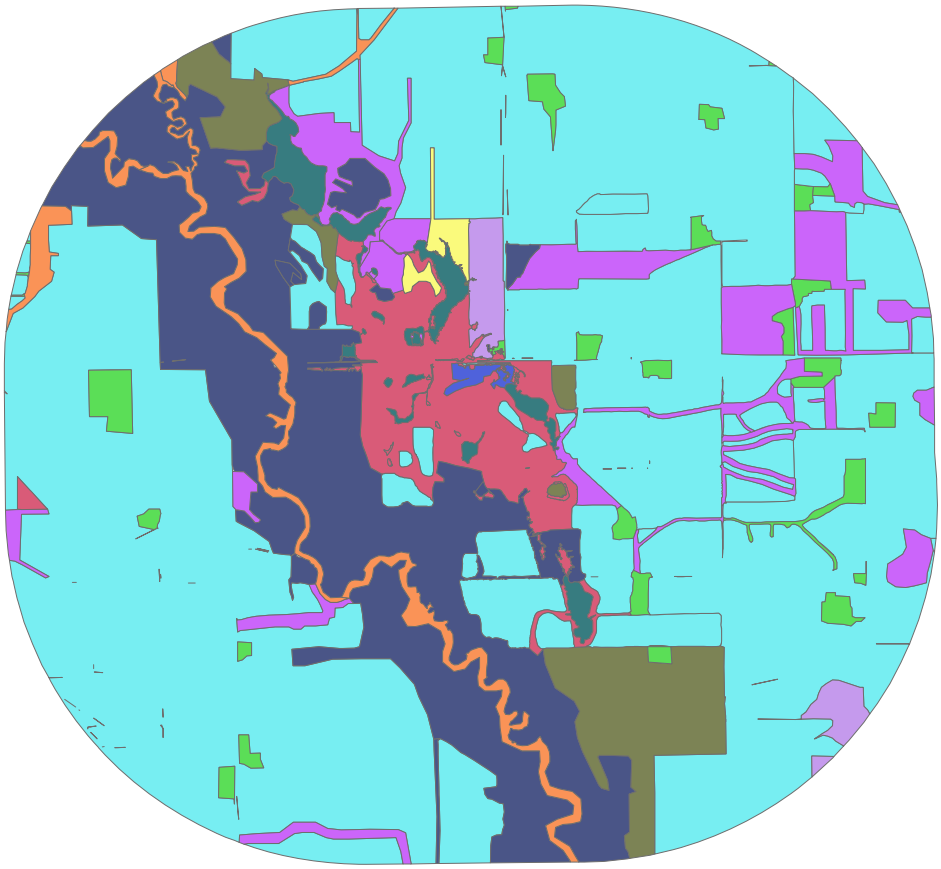


0 250 500 Meters

Legend

Local Watershed

Haye-buhr Land use/cover 2 km



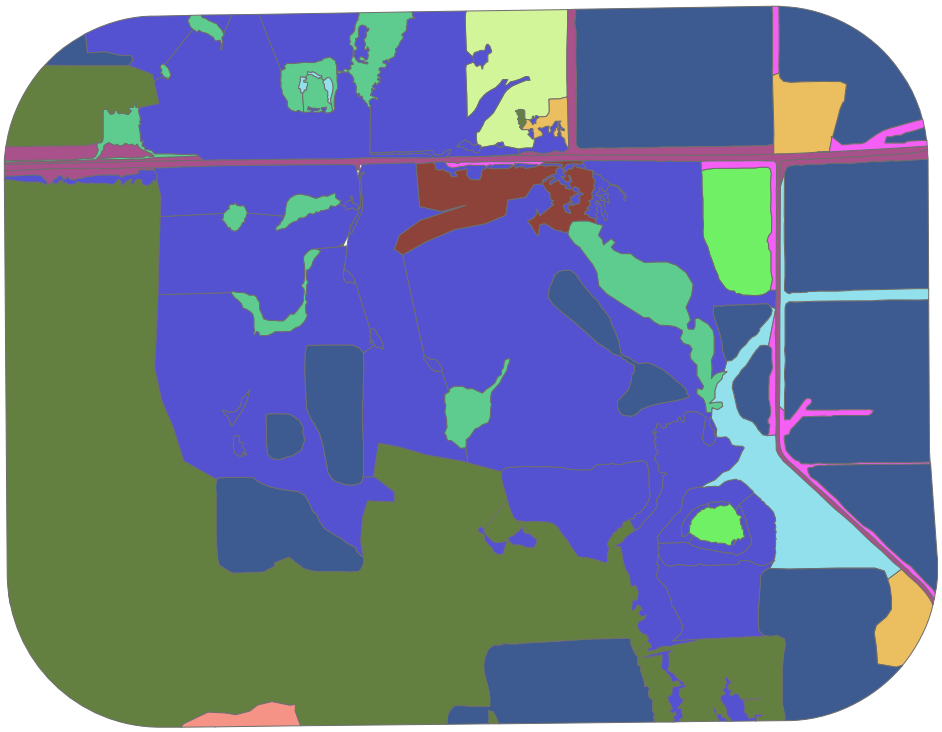
Legend

Land use/cover 2 km

- BLD
- Cropland
- Grassland
- Grassland_managed
- Palustrine_Emergent_Wetland
- Palustrine_Forested_Wetland
- Palustrine_Scrub_Shrub
- Palustrine_Unconsolidated_bottom
- Pasture
- Residential_Low_Density
- Riverine_Lower_Perennial_Unconsolidated_bottom

0 500 1,000
Meters

Haye-buhr Land use/cover 300 m



Legend

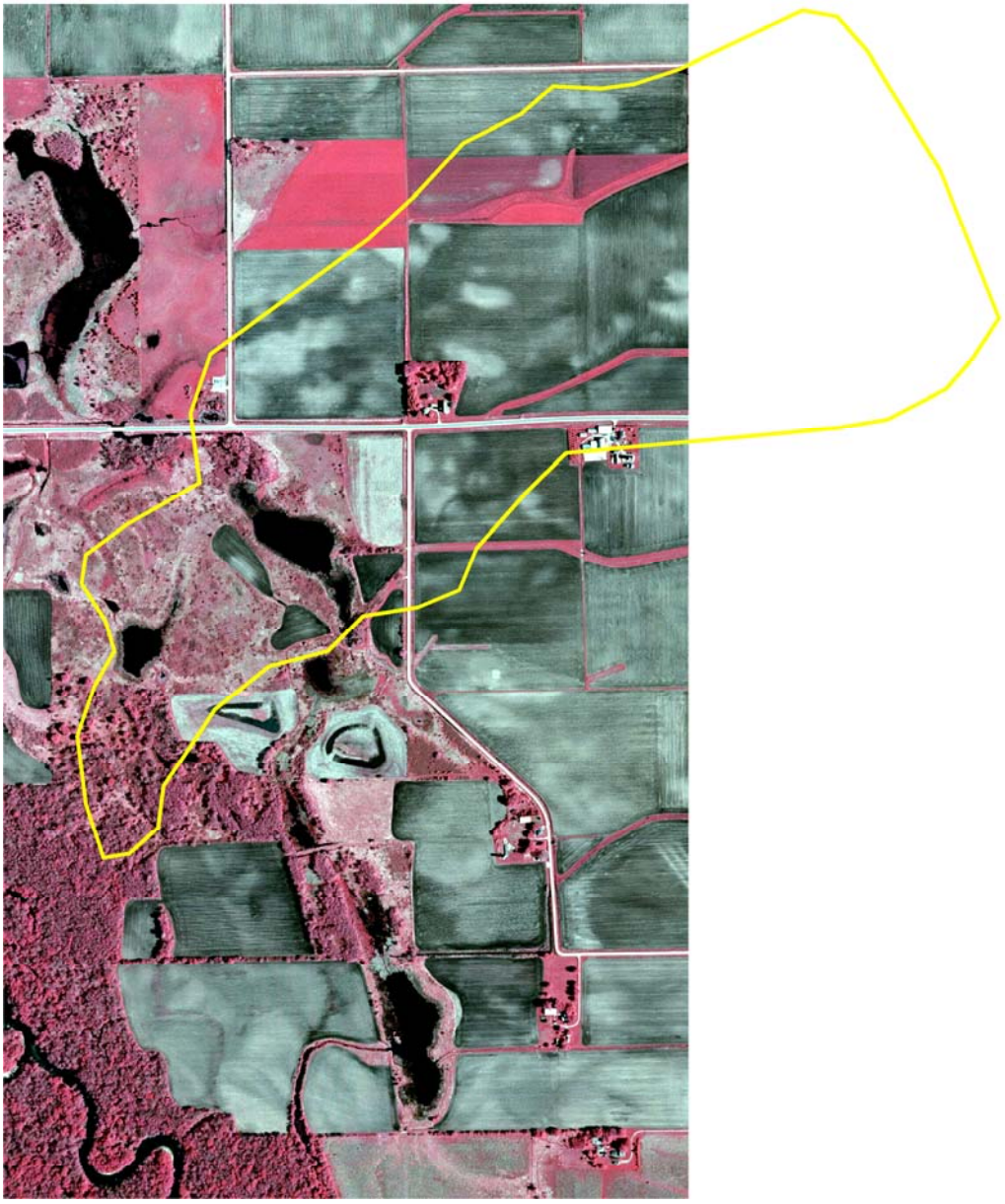
Land use/cover 300 m

- BLD
- Cropland
- Grassland
- Grassland_managed
- Palustrine_Emergent_Wetland
- Palustrine_Forested_Wetland
- Palustrine_Unconsolidated_bottom
- Pasture
- Residential_Low_Density
- Riverine_Lower_Perennial_Unconsolidated_bottom
- Roads_Secondary
- Roadside_Vegetation

0 500 1,000

Meters

Haye-buhr Local Watershed



Legend

Local Watershed

Local Watershed

0 500 1,000

Meters

Appendix B

Table 1. The nutrient and sediment load calculations for Doolittle. Area_Msq= Area in meters squared, Area_ha= Area in hectares, HEL= Highly Erodible Lands, Ag= Agriculture

VALUE	Type	AREA_Msq	Area_ha	Nitrogen Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	76531	7.65	0.44	3.37
2	Mostly Natural	0	0.00	0.45	0.00
3	Ag	495119	49.51	0.98	48.52
4	Mostly Ag	0	0.00	0.63	0.00
5	Mostly Urban	0	0.00	0.79	0.00
7	*Water/Wetlands*	15576	*1.56*		
	Total Upland Watershed Area		57.17		
	Total Watershed Loss				51.89
	Nitrogen Loss Rate for Natural Vegetation				25.15
	Index Value				**2.06**
	italics not included in calculations				

VALUE	Type	AREA_Msq	Area_ha	Phosphorus Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	76531	7.65	0.01	0.07
2	Mostly Natural	0	0.00	0.02	0.00
3	Ag	495119	49.51	0.03	1.53
4	Mostly Ag	0	0.00	0.03	0.00
5	Mostly Urban	0	0.00	0.03	0.00
7	*Water/Wetlands*	15576	*1.56*		
	Total Upland Watershed Area		57.17		
	Total Watershed Loss				1.60
	Nitrogen Loss Rate for Natural Vegetation				0.49
	Index Value				**3.29**
	italics not included in calculations				
	Total Watershed Area		58.72		
	Landscape Characteristics				
	%Natural		13.03		
	%Mostly Natural		0.00		
	%Agricultural		84.31		
	%Mostly Ag		0.00		
	%Mostly Urban		0.00		
	%Water/Wetlands		2.65		

Ag_HEL_M2	Ag_Meters2	%_Ag_as_HEL	Total Area	%_AG	% Ag_HEL*%_AG
0	495119	0.00%	587226	84.31%	0

Wetland_Ag_boundary_M	Total_wetland_Per_M	%Wetland_Ag_Boundary	%_Cleared_Land_ Watershed	Sediment_Risk_Index
0	0	0	0	0

Table 2 The nutrient and sediment load calculations for Engeldinger Marsh. Area_Msq= Area in meters squared, Area_ha= Area in hectares, HEL= Highly Erodible Lands, Ag= Agriculture

VALUE	Type	AREA_Msq	Area_ha	Nitrogen Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	514925	51.4925	0.440	22.6567
2	Mostly Natural	0	0	0.450	0
3	Ag	255890	25.589	0.980	25.07722
4	Mostly Ag		0	0.630	0
5	Mostly Urban	25709	2.5709	0.790	2.031011
7	*Water/Wetlands*	299365	*29.9365*		
	Total Upland Watershed Area		79.6524		
	Total Watershed Loss				49.76
	Nitrogen Loss Rate for Natural Vegetation				35.05
	Index Value				**1.42**
	italics not included in calculations				

VALUE	Type	AREA_Msq	Area_ha	Phosphorus Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	514925	51.4925	0.0085	0.43768625
2	Mostly Natural	0	0	0.018	0
3	Ag	255890	25.589	0.031	0.793259
4	Mostly Ag		0	0.028	0
5	Mostly Urban	25709	2.5709	0.03	0.077127
7	*Water/Wetlands*	299365	*29.9365*		
	Total Upland Watershed Area		79.6524		
	Total Watershed Loss				1.31
	Nitrogen Loss Rate for Natural Vegetation				0.68
	Index Value				**1.93**
	italics not included in calculations			1095889	
	Total Watershed Area ha		109.5889		
	Landscape Characteristics				
	%Natural		47.0		
	%Mostly Natural		0.0		
	%Agricultural		23.3		
	%Mostly Ag		0.0		
	%Mostly Urban		2.3		
	%Water/Wetlands		27.3		

Ag_HEL_M2	Ag_Meters2	%_Ag_as_HEL	Total Area	%_AG	% Ag_HEL*%_AG
4.62	25.589	18.90%	109.5889	23.35%	4.35%
Wetland_Ag_boundary_M	**Total_wetland_Per_M**	**%Wetland_Ag_Boundary**	**%_Cleared_Land_Watershed**	**Sediment_Risk_Index**	
0.00	0.00	0.00%	0.00%	0.04	

Table 3. The nutrient and sediment load calculations for Haye-Buhr. Area_Msq= Area in meters squared, Area_ha= Area in hectares, HEL= Highly Erodible Lands, Ag=Agriculture

VALUE	Type	AREA_Msq	Area_ha	Nitrogen Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	330998	33.10	0.44	14.56
2	Mostly Natural	0	0.00	0.45	0.00
3	Ag	959973	96.00	0.98	94.08
4	Mostly Ag	0	0.00	0.63	0.00
5	Mostly Urban	74314	7.43	0.79	5.87
7	*Water/Wetlands*	283902	*28.39*		
	Total Upland Watershed Area		136.53		
	Total Watershed Loss				114.51
	Nitrogen Loss Rate for Natural Vegetation				60.07
	Index Value				**1.91**
	italics not included in calculations				

VALUE	Type	AREA_Msq	Area_ha	Phosphorus Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	330998	33.10	0.01	0.28
2	Mostly Natural	0	0.00	0.02	0.00
3	Ag	959973	96.00	0.03	2.98
4	Mostly Ag	0	0.00	0.03	0.00
5	Mostly Urban	74314	7.43	0.03	0.22
7	*Water/Wetlands*	283902	*28.39*		
	Total Upland Watershed Area		136.53		
	Total Watershed Loss				3.48
	Nitrogen Loss Rate for Natural Vegetation				1.16
	Index Value				**3.00**
	italics not included in calculations				
	Total Watershed Area		164.92		
	Landscape Characteristics				
	%Natural		20.07		
	%Mostly Natural		0.00		
	%Agricultural		58.21		
	%Mostly Ag		0.00		
	%Mostly Urban		4.51		
	%Water/Wetlands		17.21		

Ag_HEL_M2	Ag_Meters2	%_Ag_as_HEL	Total Area	%_AG	% Ag_HEL*%_AG
13199	959973	1.37%	1649187	58.21%	0.80%
Wetland_Ag_boundary_M	**Total_wetland_Per_M**	**%Wetland_Ag_Boundary**	**%_Cleared_Land_Watershed**	**Sediment_Risk_Index**	
0	0	0	0	0.01	

Table 4. The nutrient and sediment load calculations for Grooms. Area_Msq= Area in meters squared, Area_ha= Area in hectares, HEL= Highly Erodible Lands, Ag=Agriculture

VALUE	Type	AREA_Msq	Area_ha	Nitrogen Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	37196	3.72	0.44	1.64
2	Mostly Natural	0	0.00	0.45	0.00
3	Ag	96645	9.66	0.98	9.47
4	Mostly Ag		0.00	0.63	0.00
5	Mostly Urban	750	0.08	0.79	0.06
7	*Water/Wetlands*	20385	*2.04*		
	Total Upland Watershed Area		13.46		
	Total Watershed Loss				11.17
	Nitrogen Loss Rate for Natural Vegetation				5.92
	Index Value				**1.89**
	italics not included in calculations				

VALUE	Type	AREA_Msq	Area_ha	Phosphorus Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	37196	3.72	0.01	0.03
2	Mostly Natural	0	0.00	0.02	0.00
3	Ag	96645	9.66	0.03	0.30
4	Mostly Ag		0.00	0.03	0.00
5	Mostly Urban	750	0.08	0.03	0.00
7	*Water/Wetlands*	20385	*2.04*		
	Total Upland Watershed Area		13.46		
	Total Watershed Loss				0.33
	Nitrogen Loss Rate for Natural Vegetation				0.11
	Index Value				**2.91**
	italics not included in calculations				
	Total Watershed Area		15.50		
	Landscape Characteristics				
	%Natural		24.00		
	%Mostly Natural		0.00		
	%Agricultural		62.36		
	%Mostly Ag		0.00		
	%Mostly Urban		0.48		
	%Water/Wetlands		13.15		

Ag_HEL_M2	Ag_Meters2	%_Ag_as_HEL	Total Area	%_AG	% Ag_HEL*%_AG/100
6986	96645	7.23%	155300	62.23%	4.50%
Wetland_Ag_boundary_M	**Total_wetland_Per_M**	**%Wetland_Ag_Boundary**	**%_Cleared_Land_Watershed**	**Sediment_Risk_Index**	
0	2787	0	0	0.04	

Table 5. The nutrient and sediment load calculations for Jarvis. Area_Msq= Area in meters squared, Area_ha= Area in hectares, HEL= Highly Erodible Lands, Ag=Agriculture

Value	Type	Area_Msq	Area_ha	Nitrogen Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	600904	60.09	0.44	26.44
2	Mostly Natural	0	0.00	0.45	0.00
3	Ag	390732	39.07	0.98	38.29
4	Mostly Ag	0	0.00	0.63	0.00
5	Mostly Urban	101858	10.19	0.79	8.05
7	*Water/Wetlands*	213204	*21.32*		
	Total Upland Watershed Area		109.35		
	Total Watershed Loss				72.78
	Nitrogen Loss Rate for Natural Vegetation				48.11
	Index Value				**1.51**

italics not included in calculations

	Type	Area_Msq	Area_ha	Phosphorus Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
	Natural	600904	60.09	0.01	0.51
	Mostly Natural	0	0.00	0.02	0.00
	Ag	390732	39.07	0.03	1.21
	Mostly Ag	0	0.00	0.03	0.00
	Mostly Urban	101858	10.19	0.03	0.31
	Water/Wetlands	213204	*21.32*		
	Total Upland Watershed Area		109.35		
	Total Watershed Loss				2.03
	Phosphorus Loss Rate for Natural Vegetation				0.93
	Index Value				**2.18**

italics not included in calculations

Total Watershed Area ha	130.67		
Landscape Characteristics			
%Natural	45.99		
%Mostly Natural	0.00		
%Agricultural	29.90		
%Mostly Ag	0.00		
%Mostly Urban	7.80		
%Water/Wetlands	16.32		

Ag_HEL_M2	Ag_Meters2	%_Ag_as_HEL	Total Area	%_AG	% Ag_HEL*%_AG
13725	390732	3.51%	1306698	29.90%	1.05%
Wetland_Ag_boundary_M	**Total_wetland_Per_M**	**%Wetland_Ag_Boundary**	**%_Cleared_Land_Watershed**	**Sediment_Risk_Index**	
0	3172	0	0	0.01	

Table 6. The nutrient and sediment load calculations for New Hampton. Area_Msq= Area in meters squared, Area_ha= Area in hectares, HEL= Highly Erodible Lands, Ag=Agriculture

VALUE	Type	AREA_Msq	Area_ha	Nitrogen Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	216023	21.60	0.44	9.51
2	Mostly Natural	0	0.00	0.45	0.00
3	Ag	2859860	285.99	0.98	280.27
4	Mostly Ag		0.00	0.63	0.00
5	Mostly Urban	459513	45.95	0.79	36.30
7	*Water/Wetlands*	*73974*	*7.40*		
	Total Upland Watershed Area		353.54		
	Total Watershed Loss				326.07
	Nitrogen Loss Rate for Natural Vegetation				155.56
	Index Value				**2.10**

italics not included in calculations

VALUE	Type	AREA_Msq	Area_ha	Phosphorus Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	216023	21.60	0.01	0.18
2	Mostly Natural	0	0.00	0.02	0.00
3	Ag	2859860	285.99	0.03	8.87
4	Mostly Ag		0.00	0.03	0.00
5	Mostly Urban	459513	45.95	0.03	1.38
7	*Water/Wetlands*	*73974*	*7.40*		
	Total Upland Watershed Area		353.54		
	Total Watershed Loss				10.43
	Nitrogen Loss Rate for Natural Vegetation				3.01
	Index Value				**3.47**

italics not included in calculations

Total Watershed Area ha	360.94
Landscape Characteristics	
%Natural	5.99
%Mostly Natural	0.00
%Agricultural	79.23
%Mostly Ag	0.00
%Mostly Urban	12.73
%Water/wetlands	2.05

Ag_HEL_M2	Ag_Meters2	%_Ag_as_HEL	Total Area	%_AG	% Ag_HEL*%_AG
20424	2859860	0.71%	3609370	79.23%	0.57%
Wetland_Ag_boundary_M	**Total_wetland_Per_M**	**%Wetland_Ag_Boundary**	**%_Cleared_Land_Watershed**	**Sediment_Risk_Index**	
0	453289	0	0	0.01	

Table 7. The nutrient and sediment load calculations for Palisades. Area_Msq= Area in meters squared, Area_ha= Area in hectares, HEL= Highly Erodible Lands, Ag=Agriculture

VALUE	Type	AREA_Msq	Area_ha	Nitrogen Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	59027	5.90	0.44	2.60
2	Mostly Natural	0	0.00	0.45	0.00
3	Ag	149100	14.91	0.98	14.61
4	Mostly Ag	0	0.00	0.63	0.00
5	Mostly Urban	134	0.01	0.79	0.01
7	*Water/Wetlands*	17923	*1.79*		
	Total Upland Watershed Area less Wetlands		20.83		
	Total Watershed Loss				17.22
	Nitrogen Loss Rate for Natural Vegetation				9.16
	Index Value				**1.88**

italics not included in calculations

VALUE	Type	AREA_Msq	Area_ha	Phosphorus Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	59027	5.90	0.01	0.05
2	Mostly Natural	0	0.00	0.02	0.00
3	Ag	149100	14.91	0.03	0.46
4	Mostly Ag	0	0.00	0.03	0.00
5	Mostly Urban	134	0.01	0.03	0.00
7	*Water/Wetlands*	17923	*1.79*		
	Total Upland Watershed Area less Wetlands		20.83		
	Total Watershed Loss				0.51
	Nitrogen Loss Rate for Natural Vegetation				0.18
	Index Value				**2.90**

italics not included in calculations

Total upland watershed area ha	22.62
Landscape Characteristics	
%Natural	26.10
%Mostly Natural	0.00
%Agricultural	65.92
%Mostly Ag	0.00
%Mostly Urban	0.06
%Water/Wetlands	7.92

Ag_HEL_M2	Ag_Meters2	%_Ag_as_HEL	Total Area	%_AG	% Ag_HEL*%_AG
60023	149100	40.26%	226184	65.92%	26.54%
Wetland_Ag_boundary_M	**Total_wetland_Per_M**	**%Wetland_Ag_Boundary**	**%_Cleared_Land_Watershed**	**Sediment_Risk_Index**	
0	10904	0	0	0.27	

Table 8. The nutrient and sediment load calculations for Pleasantville. Area_Msq= Area in meters squared, Area_ha= Area in hectares, HEL= Highly Erodible Lands, Ag=Agriculture

VALUE	Type	AREA_Msq	Area_ha	Nitrogen Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	62637	6.26	0.44	2.76
2	Mostly Natural	0	0.00	0.45	0.00
3	Ag	371598	37.16	0.98	36.42
4	Mostly Ag	0	0.00	0.63	0.00
5	Mostly Urban	15272	1.53	0.79	1.21
7	*Water/Wetlands*	20199	*2.02*		
		Total Upland Watershed Area	44.95		
					40.38
		Total Watershed Loss Nitrogen Loss Rate for Natural Vegetation			19.78
		Index Value			**2.04**

italics not included in calculations

VALUE	Type	AREA_Msq	Area_ha	Phosphorus Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	62637	6.26	0.01	0.05
2	Mostly Natural	0	0.00	0.02	0.00
3	Ag	371598	37.16	0.03	1.15
4	Mostly Ag	0	0.00	0.03	0.00
5	Mostly Urban	15272	1.53	0.03	0.05
7	*Water/Wetlands*	20199	*2.02*		
		Total Upland Watershed Area	44.95		
					1.25
		Total Watershed Loss Nitrogen Loss Rate for Natural Vegetation			0.38
		Index Value			**3.27**

italics not included in calculations

Total Watershed Area ha	46.97		
Landscape Characteristics			
%Natural	13.34		
%Mostly Natural	0.00		
%Agricultural	79.11		
%Mostly Ag	0.00		
%Mostly Urban	3.25		
%Water/Wetlands	4.30		

Ag_HEL_M2	Ag_Meters2	%_Ag_as_HEL	Total Area	%_AG	% Ag_HEL*%_AG
68625	371598	18.47%	469706	79.11%	14.61%
Wetland_Ag_boundary_M	**Total_wetland_Per_M**	**%Wetland_Ag_Boundary**	**%_Cleared_Land_Watershed**	**Sediment_Risk_Index**	
0	208800	0	0	0.15	

Table 9. The nutrient and sediment load calculations for South Point. Area_Msq= Area in meters squared, Area_ha= Area in hectares, HEL= Highly Erodible Lands, Ag=Agriculture

VALUE	Type	AREA_Msq	Area_ha	Nitrogen Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	1242024	124.20	0.44	54.65
2	Mostly Natural	0	0.00	0.45	0.00
3	Ag	2064649	206.46	0.98	202.34
4	Mostly Ag	0	0.00	0.63	0.00
5	Mostly Urban	347795	34.78	0.79	27.48
7	*Water/Wetlands*	77096	*7.71*		
	Total Upland Watershed Area		365.45		
	Total Watershed Loss				284.46
	Nitrogen Loss Rate for Natural Vegetation				160.80
	Index Value				**1.77**

italics not included in calculations

VALUE	Type	AREA_Msq	Area_ha	Phosphorus Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	1242024	124.20	0.01	1.06
2	Mostly Natural	0	0.00	0.02	0.00
3	Ag	2064649	206.46	0.03	6.40
4	Mostly Ag	0	0.00	0.03	0.00
5	Mostly Urban	347795	34.78	0.03	1.04
7	*Water/Wetlands*	77096	*7.71*		
	Total Upland Watershed Area		365.45		
	Total Watershed Loss				8.50
	Nitrogen Loss Rate for Natural Vegetation				3.11
	Index Value				**2.74**

italics not included in calculations

Total Watershed Area ha	373.16
Landscape Characteristics	
%Natural	33.28
%Mostly Natural	0.00
%Agricultural	55.33
%Mostly Ag	0.00
%Mostly Urban	9.32
%Water/Wetlands	2.07

Ag_HEL_M2	Ag_Meters2	%_Ag_as_HEL	Total Area	%_AG	% Ag_HEL*%_AG
411525	2064649	19.93%	3731564	55.33%	11.03%
Wetland_Ag_boundary_M	**Total_wetland_Per_M**	**%Wetland_Ag_Boundary**	**%_Cleared_Land_Watershed**	**Sediment_Risk_Index**	
0	5469	0	0	0.11	

Table 10. The nutrient and sediment load calculations for Wickiup Hill. Area_Msq= Area in meters squared, Area_ha= Area in hectares, HEL= Highly Erodible Lands, Ag=Agriculture

VALUE	Type	AREA_Msq	Area_ha	Nitrogen Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	2133068	213.31	0.44	93.85
2	Mostly Natural	0	0.00	0.45	0.00
3	Ag	487382	48.74	0.98	47.76
4	Mostly Ag	0	0.00	0.63	0.00
5	Mostly Urban	207001	20.70	0.79	16.35
7	*Water/Wetlands*	39951	*4.00*		
		Total Upland Watershed Area	282.75		
					157.97
		Total Watershed Loss Nitrogen Loss Rate for Natural Vegetation			124.41
		Index Value			**1.27**
		italics not included in calculations			

VALUE	Type	AREA_Msq	Area_ha	Phosphorus Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	2133068	213.31	0.01	1.81
2	Mostly Natural	0	0.00	0.02	0.00
3	Ag	487382	48.74	0.03	1.51
4	Mostly Ag	0	0.00	0.03	0.00
5	Mostly Urban	207001	20.70	0.03	0.62
7	*Water/Wetlands*	39951	*4.00*		
		Total Upland Watershed Area	282.75		
					3.94
		Total Watershed Loss Nitrogen Loss Rate for Natural Vegetation			2.40
		Index Value			**1.64**
		italics not included in calculations			

Total Watershed Area ha	286.74
Landscape Characteristics	
%Natural	74.39
%Mostly Natural	0.00
%Agricultural	17.00
%Mostly Ag	0.00
%Mostly Urban	7.22
%Water/Wetlands	1.39

Ag_HEL_M2	Ag_Meters2	%_Ag_as_HEL	Total Area	%_AG	% Ag_HEL*%_AG
185198	487396	38.00%	2867702	17.00%	6.46%
Wetland_Ag_boundary_M	**Total_wetland_Per_M**	**%Wetland_Ag_Boundary**	**%_Cleared_Land_Watershed**	**Sediment_Risk_Index**	
514	5537	9.28%	0	0.16	

Table 11. The nutrient and sediment load calculations for Brush Creek. Area_Msq= Area in meters squared, Area_ha= Area in hectares, HEL= Highly Erodible Lands, Ag=Agriculture

VALUE	Type	AREA_Msq	Area_ha	Nitrogen Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	724268	72.4268	0.440	31.867792
2	Mostly Natural	0	0	0.450	0
3	Ag	4269431	426.9431	0.980	418.404238
4	Mostly Ag	0	0	0.630	0
5	Mostly Urban	754273	75.4273	0.790	59.587567
7	*Water/Wetlands*	153717	*15.3717*		
		Total Upland Watershed Area	574.7972		
					509.86
		Total Watershed Loss Nitrogen Loss Rate for Natural Vegetation			252.91
		Index Value			**2.02**

italics not included in calculations

VALUE	Type	AREA_Msq	Area_ha	Phosphorus Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	724268	72.4268	0.0085	0.6156278
2	Mostly Natural	0	0	0.018	0
3	Ag	4269431	426.9431	0.031	13.2352361
4	Mostly Ag	0	0	0.028	0
5	Mostly Urban	754273	75.4273	0.03	2.262819
7	*Water/Wetlands*	153717	*15.3717*		
		Total Upland Watershed Area	574.7972		
					16.11
		Total Watershed Loss Nitrogen Loss Rate for Natural Vegetation			4.89
		Index Value			**3.30**

italics not included in calculations

Total Watershed Area ha	590.1689
Landscape Characteristics	
%Natural	12.3
%Mostly Natural	0.0
%Agricultural	72.3
%Mostly Ag	0.0
%Mostly Urban	12.8
%Water/Wetlands	2.6

Ag_HEL_M2	Ag_Meters2	%_Ag_as_HEL	Total Area	%_AG	% Ag_HEL*%_AG
2281400	4269490	53.43%	5901400	72.35%	38.66%
Wetland_Ag_boundary_M	**Total_wetland_Per_M**	**%Wetland_Ag_Boundary**	**%_Cleared_Land_Watershed**	**Sediment_Risk_Index**	
397	5299	7.49%	0	0.46	

Table 12. The nutrient and sediment load calculations for Badger Creek. Area_Msq= Area in meters squared, Area_ha= Area in hectares, HEL= Highly Erodible Lands, Ag=Agriculture

VALUE	Type	AREA_Msq	Area_ha	Nitrogen Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	496799	49.68	0.44	21.86
2	Mostly Natural	0	0.00	0.45	0.00
3	Ag	584387	58.44	0.98	57.27
4	Mostly Ag	0	0.00	0.63	0.00
5	Mostly Urban	0	0.00	0.79	0.00
7	*Water/Wetlands*	9822	*0.98*		
		Total Upland Watershed Area	108.12		
		Total Watershed Loss			79.13
		Nitrogen Loss Rate for Natural Vegetation			47.57
		Index Value			**1.66**

italics not included in calculations

VALUE	Type	AREA_Msq	Area_ha	Phosphorus Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	496799	49.68	0.01	0.42
2	Mostly Natural	0	0.00	0.02	0.00
3	Ag	584387	58.44	0.03	1.81
4	Mostly Ag	0	0.00	0.03	0.00
5	Mostly Urban	0	0.00	0.03	0.00
7	*Water/Wetlands*	9822	*0.98*		
		Total Upland Watershed Area	108.12		
		Total Watershed Loss			2.23
		Nitrogen Loss Rate for Natural Vegetation			0.92
		Index Value			**2.43**

italics not included in calculations

Total Watershed Area ha	109.10		
Landscape Characteristics			
%Natural	45.54		
%Mostly Natural	0.00		
%Agricultural	53.56		
%Mostly Ag	0.00		
%Mostly Urban	0.00		
%Water/Wetlands	0.90		

Ag_HEL_M2	Ag_Meters2	%_Ag_as_HEL	Total Area	%_AG	% Ag_HEL*%_AG
472220	584461	80.80%	1091091	53.57%	43.28%
Wetland_Ag_boundary_M	**Total_wetland_Per_M**	**%Wetland_Ag_Boundary**	**%_Cleared_Land_Watershed**	**Sediment_Risk_Index**	
0	11662	0	0	0.43	

Table 13. The nutrient and sediment load calculations for Mink Creek. Area_Msq= Area in meters squared, Area_ha= Area in hectares, HEL= Highly Erodible Lands, Ag=Agriculture

VALUE	Type	AREA_Msq	Area_ha	Nitrogen Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	165249	16.52	0.44	7.27
2	Mostly Natural	0	0.00	0.45	0.00
3	Ag	1397752	139.78	0.98	136.98
4	Mostly Ag	0	0.00	0.63	0.00
5	Mostly Urban	25220	2.52	0.79	1.99
7	*Water/Wetlands*	69107	*6.91*		
		Total Upland Watershed Area	158.82		
		Total Watershed Loss			146.24
		Nitrogen Loss Rate for Natural Vegetation			69.88
		Index Value			**2.09**
		italics not included in calculations			

VALUE	Type	AREA_Msq	Area_ha	Phosphorus Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	165249	16.52	0.01	0.14
2	Mostly Natural	0	0.00	0.02	0.00
3	Ag	1397752	139.78	0.03	4.33
4	Mostly Ag	0	0.00	0.03	0.00
5	Mostly Urban	25220	2.52	0.03	0.08
7	*Water/Wetlands*	69107	*6.91*		
		Total Upland Watershed Area	158.82		
		Total Watershed Loss			4.55
		Nitrogen Loss Rate for Natural Vegetation			1.35
		Index Value			**3.37**
		italics not included in calculations			

Total Watershed Area ha	165.73		
Landscape Characteristics			
%Natural	9.97		
%Mostly Natural	0.00		
%Agricultural	84.34		
%Mostly Ag	0.00		
%Mostly Urban	1.52		
%Water/Wetlands	4.17		

Ag_HEL_M2	Ag_Meters2	%_Ag_as_HEL	Total Area	%_AG	% Ag_HEL*%_AG
0	1397600	0	1657324	84.33%	0
Wetland_Ag_boundary_M	**Total_wetland_Per_M**	**%Wetland_Ag_Boundary**	**%_Cleared_Land_Watershed**	**Sediment_Risk_Index**	
0	5995	0	0	0	

Table 14. The nutrient and sediment load calculations for Dike. Area_Msq= Area in meters squared, Area_ha= Area in hectares, HEL= Highly Erodible Lands, Ag=Agriculture

VALUE	Type	AREA_Msq		Area_ha	Nitrogen Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	110291	11.03		0.44	4.85
2	Mostly Natural	0	0.00		0.45	0.00
3	Ag	3920164	392.02		0.98	384.18
4	Mostly Ag	0	0.00		0.63	0.00
5	Mostly Urban	47566	4.76		0.79	3.76
7	*Water/Wetlands*	5862	*0.59*			
		Total Upland Watershed Area	407.80			
		Total Watershed Loss				392.79
		Nitrogen Loss Rate for Natural Vegetation				179.43
		Index Value				**2.19**
		italics not included in calculations				

VALUE	Type	AREA_Msq		Area_ha	Phosphorus Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	110291	11.03		0.01	0.09
2	Mostly Natural	0	0.00		0.02	0.00
3	Ag	3920164	392.02		0.03	12.15
4	Mostly Ag	0	0.00		0.03	0.00
5	Mostly Urban	47566	4.76		0.03	0.14
7	*Water/Wetlands*	5862	*0.59*			
		Total Upland Watershed Area	407.80			
		Total Watershed Loss				12.39
		Nitrogen Loss Rate for Natural Vegetation				3.47
		Index Value				**3.57**
		italics not included in calculations				

Total Watershed Area ha	408.39		
Landscape Characteristics			
%Natural	2.70		
%Mostly Natural	0.00		
%Agricultural	95.99		
%Mostly Ag	0.00		
%Mostly Urban	1.16		
%Water/Wetlands	0.14		

Ag_HEL_M2	Ag_Meters2	%_Ag_as_HEL	Total Area	%_AG	% Ag_HEL*%_AG
90196	3920170	2.30%	4134847	94.81%	2.18%
Wetland_Ag_boundary_M	**Total_wetland_Per_M**	**%Wetland_Ag_Boundary**	**%_Cleared_Land_Watershed**	**Sediment_Risk_Index**	
0	1386	0	0	0.02	

Table 15. The nutrient and sediment load calculations for Boevers. Area_Msq= Area in meters squared, Area_ha= Area in hectares, HEL= Highly Erodible Lands, Ag=Agriculture

VALUE	Type	AREA_Msq	Area_ha	Nitrogen Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	0	0.00	0.44	0.00
2	Mostly Natural	0	0.00	0.45	0.00
3	Ag	35127	3.51	0.98	3.44
4	Mostly Ag	0	0.00	0.63	0.00
5	Mostly Urban	0	0.00	0.79	0.00
7	*Water/Wetlands*	2013	*0.20*		
		Total Upland Watershed Area	3.51		
					3.44
		Total Watershed Loss Nitrogen Loss Rate for Natural Vegetation			1.55
		Index Value			**2.23**

italics not included in calculations

VALUE	Type	AREA_Msq	Area_ha	Phosphorus Loss Rate (kg/ha/yr)	Total loss per Veg type (kg/yr)
1	Natural	0	0.00	0.01	0.00
2	Mostly Natural	0	0.00	0.02	0.00
3	Ag	35127	3.51	0.03	0.11
4	Mostly Ag	0	0.00	0.03	0.00
5	Mostly Urban	0	0.00	0.03	0.00
7	*Water/Wetlands*	2013	*0.20*		
		Total Upland Watershed Area	3.51		
					0.11
		Total Watershed Loss Nitrogen Loss Rate for Natural Vegetation			0.03
		Index Value			**3.65**

italics not included in calculations

Total Watershed Area ha	3.71	
Landscape Characteristics		
%Natural	0.00	
%Mostly Natural	0.00	
%Agricultural	94.58	
%Mostly Ag	0.00	
%Mostly Urban	0.00	
%Water/Wetlands	5.42	

Ag_HEL_M2	Ag_Meters2	%_Ag_as_HEL	Total Area	%_AG	% Ag_HEL*%_AG
0	35127	0	3714	945.80%	0
Wetland_Ag_boundary_M	**Total_wetland_Per_M**	**%Wetland_Ag_Boundary**	**%_Cleared_Land_Watershed**	**Sediment_Risk_Index**	
0	452		0	0	

Appendix C

Table 1. The LDI equivalent land use/cover classifications.

Land use/cover	LDI equivalent	LDI Emergy Coefficient
Woodland	Natural System	1.00
Savanna	Natural System	1.00
BLD	Natural System	1.00
NLE	Natural System	1.00
Grassland_Managed	Natural System	1.00
Palustrine_Emergent_Wetland	Natural open Water	1.00
Palustrine_Unconsolidated_bottom_sand	Natural open Water	1.00
Palustrine_Emergent_Wetland	Natural open Water	1.00
Palustrine_Unconsolidated_Bottom	Natural open Water	1.00
Palustrine_Forested_Wetland	Natural open Water	1.00
Riverine_System	Natural open Water	1.00
Lacustrine_Unconsolidated_bottom	Natural open Water	1.00
Riverine_Lower_Perennial_Unconsolidated_Bottom	Natural open Water	1.00
Palustrine_Forested_Wetland_BLD	Natural open Water	1.00
Grassland	Improved Pasture (without livestock)	2.77
Pasture	Improved Pasture low-intensity (with live	3.41
Cropland	Row Crops	4.54
Residential_Low_Density	Singel family residential-low density	6.90
Confined_Feeding_Lots	Agriculture high-intensity	7.00
Residential_Medium_Low_Density	Singel family residential-medium-density	7.47
Residential_Medium_Density	Singel family residential-medium-density	7.47
Residential_Mediun-High_Density	Singel family residential-high-density	7.55
Roads_Primary	Highway (2 lanes)	7.81
Roadside_Vegetation	Highway (2 lanes)	7.81
Commercial	Low intensity commercial	8.00
Agricultural_Infrastructure	Low intensity commercial	8.00
Industrial	Industrial	8.32
Industrial	Industrial	8.32

Table 2. The land use/cover classifications and their equivalent EPA categories.

Land Use/Cover	EPA Catagories
Cropland	Ag
Pasture	Ag
Agricultural_Infrastructure	Mostly Ur
Commercial	Mostly Ur
Industrial	Mostly Ur
Low_Density_Residential	Mostly Ur
Primary_Roads	Mostly Ur
Residential_Low_Density	Mostly Ur
Residential_Medium_Density	Mostly Ur
Residential_Medium_Low_Density	Mostly Ur
Residential_Mediun-High_Density	Mostly Ur
Roads_Primary	Mostly Ur
Roadside_Vegetation	Mostly Ur
BLD	Natural
Grassland	Natural
Grassland_Managed	Natural
NLE	Natural
Savanna	Natural
Woodland	Natural
Palustrine_Emergent_Wetland	Water/Wet
Palustrine_Forested_Wetland	Water/Wet
Palustrine_Unconsolidated_Bottom	Water/Wet
Palustrine_Unconsolidated_bottom_sand	Water/Wet
Riverine_System	Water/Wet

Appendix H

Ecological Assessment of Compensatory Wetland Mitigation
Biodiversity Master Database

Ecological Assessment of Compensatory Wetland Mitigation
Biodiversity Master Database
Assistance Agreement #CD-98752301-0

Algae and Bacteria				
Family	**Genus**	**Species**	**Common Name**	**State Status**
Bacillariophyta	Asterionella			
Bacillariophyta	Eunotia			
Bacillariophyta	Fragilaria			
Bacillariophyta	Melosira			
Bacillariophyta	Navicula			
Bacillariophyta	Neidium			
Bacillariophyta	Nitzschia			
Bacillariophyta	Pinnularia			
Bacillariophyta	Rhopalodia			
Bacillariophyta	Synedra			
Charophyta	Closterium sp.			
Charophyta	Closterium	acerosum var. tumidum Borge?		
Charophyta	Closterium	acutum var. variabile (Lemm.) Krieger 1937		
Charophyta	Closterium	ehrenbergii var. malinvernianum (De Not.) Rabenhorst 1868		
Charophyta	Closterium	ehrenbergii var. malinvernianum?		
Charophyta	Closterium	flaccidum Delponte 1877		
Charophyta	Closterium	gracile Brebisson 1839		
Charophyta	Closterium	praelongum Brebisson 1856		
Charophyta	Closterium	pritchardianum f. attenuatum Irenee-Marie 1934		
Charophyta	Closterium	pritchardianum var. oligopunctatum Roll 1919		
Charophyta	Closterium	pseudolunula Borge 1909		
Charophyta	Closterium	pseudolunula?		
Charophyta	Closterium	rostratum Ehrenberg 1832		
Charophyta	Closterium	sigma?		
Charophyta	Closterium	venus f. major Strom 1926		
Charophyta	Closterium	sp. 3		
Charophyta	Closterium	sp. 8		
Charophyta	Closterium	sp. 10		
Charophyta	Closterium	sp. 11		
Charophyta	Closterium	sp. 14		
Charophyta	Closterium	sp. 15?		
Charophyta	Closterium	sp. 18		
Charophyta	Closterium	sp. 19		
Charophyta	Closterium	sp. 20		
Charophyta	Closterium	sp. 22		
Charophyta	Closterium	sp. 23		
Charophyta	Closterium	sp. 25		
Charophyta	Closterium	sp. 25?		
Charophyta	Closterium	sp. 26		
Charophyta	Closterium	sp. 27		
Charophyta	Closterium	sp. 28		
Charophyta	Closterium	sp. 29		
Charophyta	Closterium	sp. 30		
Charophyta	Closterium	sp. 31		
Charophyta	Closterium	sp. 32		
Charophyta	Coleochaete	orbicularis Pringsheim 1860		
Charophyta	Cosmarium	angulosum Brebisson 1856		
Charophyta	Cosmarium	angulosum var. concinnum (Rab.) West & West 1901		
Charophyta	Cosmarium	galeritum Nordstrom 1870		

Charophyta	Cosmarium	granatum Brebisson ex Ralfs 1848		
Charophyta	Cosmarium	pseudoquadratulum Prescott & Scott 1952		
Charophyta	Cosmarium	pseudoquadratulum?		
Charophyta	Cosmarium	turpinii Brebisson 1856		
Charophyta	Cosmarium	sp.		
Charophyta	Cosmarium	sp. 2		
Charophyta	Cosmarium	sp. 4		
Charophyta	Cosmarium	sp. 5		
Charophyta	Cosmarium	sp. 5?		
Charophyta	Cosmarium	sp. 6		
Charophyta	Cosmarium	sp. 7		
Charophyta	Cosmarium	sp. 8		
Charophyta	Cosmarium	sp. 8?		
Charophyta	Cosmarium	sp. 9		
Charophyta	Cosmarium	sp. 11		
Charophyta	Cosmarium	sp.12?		
Charophyta	Cosmarium	sp. 14		
Charophyta	Cosmarium	sp. 14?		
Charophyta	Cosmarium	sp. 17		
Charophyta	Cosmarium	sp. 18		
Charophyta	Cosmarium	sp. 19		
Charophyta	Cosmarium	sp. 19?		
Charophyta	Cosmarium	sp. 21		
Charophyta	Cosmarium	sp. 21?		
Charophyta	Cosmarium	sp. 22		
Charophyta	Cosmarium	sp. 22?		
Charophyta	Cosmarium	sp. 23		
Charophyta	Cosmarium	sp. 24		
Charophyta	Cosmarium	sp. 25		
Charophyta	Cosmarium	sp. 26		
Charophyta	Cosmarium	sp. 27		
Charophyta	Euastrum	elegans (Breb. in Menegh.) Kuetz. 1845		
Charophyta	Euastrum	elegans var?		
Charophyta	Euastrum	gemmatum (Breb. in Menegh.) Ralfs 1848		
Charophyta	Euastrum	verrucosum var. alatum Wolle 1884		
Charophyta	Euastrum	verrucosum Ehrenberg 1834		
Charophyta	Micrasterias	rabenhorstii Kirchner 1878		
Charophyta	Mougeotia	genuflexa?		
Charophyta	Mougeotia	sp.		
Charophyta	Mougeotia	sp. 1		
Charophyta	Mougeotia	sp. 1?		
Charophyta	Mougeotia	sp. 2		
Charophyta	Mougeotia	sp. 2?		
Charophyta	Mougeotia	sp. 4?		
Charophyta	Mougeotia	sp. 5		
Charophyta	Mougeotia	sp. 5?		
Charophyta	Mougeotia	sp. 6		
Charophyta	Mougeotia	sp. 6?		
Charophyta	Mougeotia	sp. 7		
Charophyta	Mougeotia?			
Charophyta	Penium	margaritaceum (Ehrenb.) Breb. in Ralfs 1848		
Charophyta	Pleurotaenium	minutum fa. major Lund		

Charophyta	Pleurotaenium	sp.		
Charophyta	Sirogonium	sp. 1		
Charophyta	Sirogonium	sp. 2		
Charophyta	Sirogonium	sp. 3		
Charophyta	Spirogyra	crassa Kuetzing 1843		
Charophyta	Spirogyra	sp.		
Charophyta	Spirogyra	sp. 1		
Charophyta	Spirogyra	sp. 1?		
Charophyta	Spirogyra	sp. 2		
Charophyta	Spirogyra	sp. 3		
Charophyta	Spirogyra	sp. 3?		
Charophyta	Spirogyra	sp. 6?		
Charophyta	Spirogyra	sp. 7		
Charophyta	Spirogyra	sp. 8		
Charophyta	Spirogyra	sp. 9		
Charophyta	Spirogyra	sp. 10		
Charophyta	Spirogyra	sp. 11		
Charophyta	Spirogyra	sp. 12		
Charophyta	Spirogyra	sp. 12?		
Charophyta	Spirogyra	sp. 14		
Charophyta	Spirogyra	sp. 15		
Charophyta	Spirogyra	sp. 15?		
Charophyta	Staurastrum	gracile var. nanum Wille 1880		
Charophyta	Staurastrum	paradoxum var. longipes?		
Charophyta	Staurastrum	sp.		
Charophyta	Staurastrum	sp. 1		
Charophyta	Staurastrum	sp. 2		
Charophyta	Staurastrum	sp. 3		
Charophyta	Staurastrum	sp. 3?		
Charophyta	Staurastrum	sp. 4		
Charophyta	Staurastrum	sp. 5		
Charophyta	Staurastrum	sp. 6		
Charophyta	Staurastrum	sp. 7		
Charophyta	Staurastrum	sp. 8		
Charophyta	Zygnema	sp.		
Charophyta	Zygnema	sp. 1		
Charophyta	Zygnema	sp. 2?		
Charophyta	Zygnema	sp. 3		
Charophyta	Zygnema	sp. 3?		
Charophyta	Zygnema	sp. 4		
Charophyta	Zygnema	sp. 4?		
Chlorophyta	Actinastrum	hantzschii var. fluviatile Schroeder 1899		
Chlorophyta	Ankistrodesmus	convolutus Corda 1839		
Chlorophyta	Ankistrodesmus	falcatus var. mirabilis (West & West) G. S. West 1904		
Chlorophyta	Ankistrodesmus	falcatus var. stipitatus (Chod.) Lemmermann 1908		
Chlorophyta	Aphanochaete	polychaete (Hansg.) Fritsch 1902		
Chlorophyta	Aphanochaete	repens A. Braun 1851		
Chlorophyta	Aphanochaete	sp.		
Chlorophyta	Botryococcus	braunii Kuetzing 1849		
Chlorophyta	Bulbochaete	sp.		
Chlorophyta	Chaetophora	incrassata (Huds.) Hazen 1902		
Chlorophyta	Chara	sp.		

Chlorophyta	Characium	falcatum Schroeder?		
Chlorophyta	Characium	pringsheimii A. Braun 1855		
Chlorophyta	Characium	pringsheimii?		
Chlorophyta	Characium	rostratum Reinhard 1876		
Chlorophyta	Characium	sp.		
Chlorophyta	Characium	sp. 3		
Chlorophyta	Chlamydomonas	sp.		
Chlorophyta	Chlamydomonas	sp. 1		
Chlorophyta	Chlorella	vulgaris Beyerinck 1890		
Chlorophyta	Chlorochytrium	lemnae?		
Chlorophyta	Chlorococcum?			
Chlorophyta	Lagerheimia	longiseta (Lemmermann) Wille 1909		
Chlorophyta	Cladophora	fracta var. lacustris (Kuetz.) Brand ex Heering 1921		
Chlorophyta	Cladophora	glomerata (L.) Kuetzing 1845		
Chlorophyta	Cladophora	glomerata fa. kuetzingiana (Grunow) Heering 1921		
Chlorophyta	Cladophora	glomerata?		
Chlorophyta	Cladophora	oligoclona Kutz.?		
Chlorophyta	Cladophora	sp.		
Chlorophyta	Cladophora	sp. in Prescott 1931?		
Chlorophyta	Cladophora	sp. in Prescott 1931		
Chlorophyta	Coelastrum	microporum Naegeli in A. Braun 1855		
Chlorophyta	Coelastrum	sp.		
Chlorophyta	Coleochaete	orbicularis Pringsheim 1860		
Chlorophyta	Crucigenia	quadrata Morren 1830		
Chlorophyta	Dictyosphaerium	pulchellum Wood 1874		
Chlorophyta	Eudorina	elegans Ehrenberg 1832		
Chlorophyta	Eudorina	sp?		
Chlorophyta	Gloeocystis	vesiculosa Naegeli 1849		
Chlorophyta	Gloeocystis	sp,		
Chlorophyta	Gonium	pectorale Mueller 1773		
Chlorophyta	Hydrodictyon	reticulatum (L.) Lagerheim 1883		
Chlorophyta	Kirchneriella	lunaris (Kirch.) Moebius 1894		
Chlorophyta	Microspora	sp.		
Chlorophyta	Nephrocytium	agardhianum Naegeli 1849		
Chlorophyta	Oedocladium	sp.		
Chlorophyta	Oedocladium	sp. 1		
Chlorophyta	Oedocladium	sp. 1?		
Chlorophyta	Oedocladium	sp. 2?		
Chlorophyta	Oedocladium	sp. 3?		
Chlorophyta	Oedocladium	sp. 4		
Chlorophyta	Oedocladium	sp. 5		
Chlorophyta	Oedocladium	sp. 6		
Chlorophyta	Oedocladium	sp. 6?		
Chlorophyta	Oedocladium	sp. 7		
Chlorophyta	Oedocladium	sp. 7?		
Chlorophyta	Oedocladium	sp. 8		
Chlorophyta	Oedocladium	sp. 9		
Chlorophyta	Oedocladium	sp. 10		
Chlorophyta	Oedocladium	sp. 11		
Chlorophyta	Oedocladium	sp. 12		
Chlorophyta	Oedocladium	sp. 13		
Chlorophyta	Oedocladium	sp. 14		

Chlorophyta	Oedocladium	sp. 14?		
Chlorophyta	Oedocladium	sp. 15		
Chlorophyta	Oedocladium	sp. 16		
Chlorophyta	Oedocladium	sp. 17		
Chlorophyta	Oedogonium	americanum Transeau 1917		
Chlorophyta	Oedogonium	fennicum (Tiff.) Tiffany 1934		
Chlorophyta	Oedogonium	iowense Tiffany 1924		
Chlorophyta	Oedogonium	sp.		
Chlorophyta	Oedogonium	sp. 1?		
Chlorophyta	Oedogonium	sp. 3		
Chlorophyta	Oedogonium	sp. 3?		
Chlorophyta	Oedogonium	sp. 4?		
Chlorophyta	Oedogonium	sp. 5		
Chlorophyta	Oedogonium	sp. 6		
Chlorophyta	Oedogonium	sp. 6?		
Chlorophyta	Oedogonium	sp. 9		
Chlorophyta	Oedogonium	sp. 9?		
Chlorophyta	Oedogonium	sp. 10		
Chlorophyta	Oedogonium	sp. 11		
Chlorophyta	Oedogonium	sp. 11?		
Chlorophyta	Oedogonium	sp. 12		
Chlorophyta	Oedogonium	sp. 12?		
Chlorophyta	Oedogonium	sp. 13		
Chlorophyta	Oedogonium	sp. 13?		
Chlorophyta	Oedogonium	sp. 14		
Chlorophyta	Oedogonium	sp. 14?		
Chlorophyta	Oedogonium	sp. 15		
Chlorophyta	Oedogonium	sp. 15?		
Chlorophyta	Oedogonium	sp. 16		
Chlorophyta	Oedogonium	sp. 17		
Chlorophyta	Oedogonium	sp. 18		
Chlorophyta	Oedogonium	sp. 19		
Chlorophyta	Oedogonium	sp. 19?		
Chlorophyta	Oedogonium	sp. 20		
Chlorophyta	Oedogonium	sp. 21		
Chlorophyta	Oedogonium	sp. 22		
Chlorophyta	Oocystis	borgei Snow 1903		
Chlorophyta	Oocystis	elliptica W. West 1892		
Chlorophyta	Oocystis?			
Chlorophyta	Ophiocytium	sp. 1		
Chlorophyta	Pandorina	morum (O. F. Muell.) Bory 1824		
Chlorophyta	Pediastrum	boryanum (Turp.) Meneghini 1840		
Chlorophyta	Pediastrum	boryanum var.?		
Chlorophyta	Pediastrum	boryanum var. cornutum (Raciborski) Sulek in Fott 1969		
Chlorophyta	Pediastrum	boryanum var. longicorne Raciborski 1889		
Chlorophyta	Pediastrum	boryanum var. pseudoglabrum Parra [Barrientos] 1979		
Chlorophyta	Pediastrum	boryanum?		
Chlorophyta	Pediastrum	duplex Meyen 1829		
Chlorophyta	Pediastrum	duplex var. gracilimum West & West 1895		
Chlorophyta	Pediastrum	duplex var. rugulosum Raciborski 1889		
Chlorophyta	Pediastrum	integrum var?		
Chlorophyta	Pediastrum	longecornutum (Gutwinski) A. Comas 1989		

Chlorophyta	Pediastrum	sculptatum G. M. Smith 1916		
Chlorophyta	Pediastrum	tetras (Ehrenb.) Ralfs 1844		
Chlorophyta	Pediastrum	nov. sp. 1?		
Chlorophyta	Pediastrum	nov. sp. 2?		
Chlorophyta	Phacotus	lenticularis (Ehrenb.) Stein 1878		
Chlorophyta	Phacotus	sp.		
Chlorophyta	Pleurococcus	sp.		
Chlorophyta	Protoderma	viride?		
Chlorophyta	Protoderma	viride Kuetzing 1843		
Chlorophyta	Protoderma?			
Chlorophyta	Pteromonas	angulosa (H. J. Carter) Lemmermann 1900		
Chlorophyta	Pteromonas	angulosa?		
Chlorophyta	Pteromonas	sp.		
Chlorophyta	Pteromonas	sp.?		
Chlorophyta	Pteromonas?	angulosa?		
Chlorophyta	Scenedesmus	abundans var. longicauda G. M. Smith 1916		
Chlorophyta	Scenedesmus	acuminatus (Lag.) Chodat 1902		
Chlorophyta	Scenedesmus	acuminatus var?		
Chlorophyta	Scenedesmus	alternans var. prescottii Fott & Komarek 1960		
Chlorophyta	Scenedesmus	arcuatus Lemmermann 1899		
Chlorophyta	Scenedesmus	arcuatus var. platydiscus G. M. Smith 1916		
Chlorophyta	Scenedesmus	bijuga (Turp.) Lagerheim 1893		
Chlorophyta	Scenedesmus	bijuga var. alternans (Reinsch) Hansgirg 1888		
Chlorophyta	Scenedesmus	bijuga?		
Chlorophyta	Scenedesmus	caudato-aculeolatus R. Chodat 1926		
Chlorophyta	Scenedesmus	denticulatus Lagerheim 1882		
Chlorophyta	Scenedesmus	dimorphus (Turp.) Kuetzing 1833		
Chlorophyta	Scenedesmus	intermedius R. Chodat 1926		
Chlorophyta	Scenedesmus	longus var. naegelii (de Breb.) G. M. Smith 1920		
Chlorophyta	Scenedesmus	lunatus var. alternans (n.var.)		
Chlorophyta	Scenedesmus	opoliensis P. Richter 1896		
Chlorophyta	Scenedesmus	quadricauda (Turp.) Breb. in Breb. & Godey 1835		
Chlorophyta	Scenedesmus	quadricauda var. maxima W. & G. S. West 1895		
Chlorophyta	Scenedesmus	quadricauda var. quadrispina (Chod.) G. M. Smith 1916		
Chlorophyta	Scenedesmus	quadricauda var. ecornis Ehrenb. ex Ralfs 1848		
Chlorophyta	Scenedesmus	quadricauda?		
Chlorophyta	Scenedesmus	sp.		
Chlorophyta	Scenedesmus	sp. 1		
Chlorophyta	Scenedesmus	sp. 1?		
Chlorophyta	Scenedesmus	sp. 4		
Chlorophyta	Scenedesmus	sp. 5		
Chlorophyta	Scenedesmus	sp. 8		
Chlorophyta	Scenedesmus	sp. 9		
Chlorophyta	Scenedesmus	sp. 10		
Chlorophyta	Scenedesmus	sp. 11		
Chlorophyta	Scenedesmus	sp. 12		
Chlorophyta	Scenedesmus	sp. 13		
Chlorophyta	Scenedesmus	sp. 14		
Chlorophyta	Scenedesmus?			
Chlorophyta	Selenastrum	westii G. M. Smith 1920		
Chlorophyta	Selenastrum	sp. 1		
Chlorophyta	Sorastrum	americanum var. undulatum G. M. Smith 1918		

Chlorophyta	Sphaerocystis	schroeteri Chodat 1897		
Chlorophyta	Stichococcus?			
Chlorophyta	Stigeoclonium	nanum Kuetzing 1849		
Chlorophyta	Stigeoclonium	polymorphum (Franke) Heering 1914		
Chlorophyta	Stigeoclonium	sp.		
Chlorophyta	Stigeoclonium		Pseudochaete	
Chlorophyta	Tetraedron	hastatum (Reinsch) Hansgirg 1888		
Chlorophyta	Tetraedron	minimum (A. Braun) Hansgirg 1888		
Chlorophyta	Tetraedron	regulare? Kuetz.		
Chlorophyta	Tetraedron	sp.		
Chlorophyta	Tetraspora	gelatinosa (Vauch.) Desvaux 1818		
Chlorophyta	Tetraspora	lacustris Lemmermann 1898		
Chlorophyta	Tetraspora	lubrica (Roth) Agardh 1824		
Chlorophyta	Tetrastrum	heteracanthum (Nordstedt) Chodat 1895		
Chlorophyta	Uronema	sp.		
Chlorophyta	Volvox	aureus Ehrenberg 1832		
Chlorophyta	Volvox	sp.		
Chlorophyta			small monads	
Chlorophyta			green cell with bristle	
Chlorophyta			unknown filament	
Chlorophyta			unknown genus	
Chlorophyta			swarm cells & germlings	
Chlorophyta			monads	
Chlorophyta			monad 1	
Chlorophyta			monad 2	
Chlorophyta			unknown coccoid green	
Chlorophyta			unknown colony	
Chlorophyta			green monad	
Chlorophyta			coccoid green colony	
Chlorophyta			coccoid green	
Chlorophyta			oval monads	
Chrysophyta	Anthophysa	vegetans (O. F. Mueller) Stein 1878		
Chrysophyta	Characiopsis	sp. 1		
Chrysophyta	Cladonema	pauperum Pascher 1942		
Chrysophyta	Dinobryon	sp.		
Chrysophyta	Mallomonas	sp.		
Chrysophyta	Ochromonas	sp.		
Chrysophyta	Ophiocytium	arbusculum (A. Br.) Rabenhorst 1868		
Chrysophyta	Ophiocytium	cochleare (Eichw.) A. Braun 1855		
Chrysophyta	Ophiocytium	parvulum (Perty) A. Braun 1855		
Chrysophyta	Synura	uvella Ehrenberg 1838		
Chrysophyta	Synura	sp.		
Chrysophyta	Tribonema	sp.		
Chrysophyta	Tribonema	sp. 1		
Chrysophyta	Tribonema	sp. 1?		
Chrysophyta	Tribonema	sp. 2?		
Chrysophyta	Tribonema	sp. 3		
Chrysophyta	Tribonema	sp. 4		
Chrysophyta	Tribonema	sp. 5		
Chrysophyta	Tribonema	sp. 5?		
Chrysophyta	Tribonema	sp. 6		
Chrysophyta	Tribonema	sp. 7		

Chrysophyta	Tribonema	sp. 8		
Chrysophyta	Vaucheria	hamata (Vauch.) de Candolle 1805		
Chrysophyta	Vaucheria	orthocarpa Reinsch 1887		
Chrysophyta	Vaucheria	sp.		
Chrysophyta	Vaucheria	sp. 1		
Chrysophyta	Vaucheria	sp. 3		
Chrysophyta	Vaucheria	sp. 6		
Chrysophyta			unknown flagellate	
Chrysophyta			monad	
Chrysophyta			unknown chrysomonad	
Chrysophyta			dormant flagellate	
Cryptophyta	Cryptomonas	sp.		
Cryptophyta	Cryptomonas	sp. 3		
Cryptophyta			small monads	
Cryptophyta			cryptomonads	
Cyanobacteria	Anabaena	affinis Lemmermann 1898		
Cyanobacteria	Anabaena	affinis?		
Cyanobacteria	Anabaena	augstumalis var. marchia Lemmermann 1905		
Cyanobacteria	Anabaena	circinalis Rabenhorst ex Bornet ex Flahault 1888		
Cyanobacteria	Anabaena	inaequalis (Kuetz.) Bornet ex Flahault 1888		
Cyanobacteria	Anabaena	verrucosa Boye-Petersen 1923		
Cyanobacteria	Anabaena	wisconsinense Prescott 1944 var?		
Cyanobacteria	Anabaena	sp.		
Cyanobacteria	Anabaena	sp. 1		
Cyanobacteria	Anabaena	sp. 2		
Cyanobacteria	Anabaena	sp. 3		
Cyanobacteria	Anabaena	sp. 3?		
Cyanobacteria	Anabaena	sp. 3?		
Cyanobacteria	Anabaena	sp. 4		
Cyanobacteria	Anabaena	sp. 6		
Cyanobacteria	Anabaena	sp. 6?		
Cyanobacteria	Anabaena	sp. 7		
Cyanobacteria	Anabaena	sp. 7?		
Cyanobacteria	Anabaena	sp. 8		
Cyanobacteria	Anabaena	sp. 8?		
Cyanobacteria	Anabaena	sp. 9		
Cyanobacteria	Anabaena	sp. 9?		
Cyanobacteria	Anabaena?			
Cyanobacteria	Anacystis	sp.		
Cyanobacteria	Anacystis?			
Cyanobacteria	Aphanocapsa	incerta (Lemmermann) Cronberg et Komarek 1994		
Cyanobacteria	Aphanocapsa	pulchra (Kuetz.) Rabenhorst 1865		
Cyanobacteria	Aphanocapsa	sp.		
Cyanobacteria	Aphanocapsa?			
Cyanobacteria	Aphanothece	microscopica Naegeli 1849		
Cyanobacteria	Aphanothece	stagnina (Spreng.) A. Braun in Rabenhorst 1864-1869		
Cyanobacteria	Aphanothece	sp.		
Cyanobacteria	Arthrospira	jenneri (Kuetz.) Stitzenberger ex Gomont 1892		
Cyanobacteria	Calothrix	sp. 2		
Cyanobacteria	Calothrix	sp. 3		
Cyanobacteria	Calothrix?			
Cyanobacteria	Chlorogloea	microcystoides Geitler 1925		
Cyanobacteria	Chroococcus	minutus?		

Cyanobacteria	Chroococcus	pallidus Naegeli 1849		
Cyanobacteria	Chroococcus	turgidus (Kuetz.) Naegeli 1849		
Cyanobacteria	Chroococcus	dispersum?		
Cyanobacteria	Chroococcus	minor (Kuetz.) Naegeli 1849		
Cyanobacteria	Coelosphaerium	naegelianum Unger 1854		
Cyanobacteria	Coelosphaerium	sp. 1		
Cyanobacteria	Cyanotetras	sp.		
Cyanobacteria	Geitleribactron	sp.		
Cyanobacteria	Gloeocapsa	aeruginosa (Carm.) Kuetzing 1843		
Cyanobacteria	Gloeocapsa	conglomerata Kuetzing 1846		
Cyanobacteria	Gloeocapsa	sp.		
Cyanobacteria	Gloeotrichia	pisum?		
Cyanobacteria	Gomphosphaeria	aponina Kuetzing 1836		
Cyanobacteria	Heteroleibleinia	sp.		
Cyanobacteria	Lyngbya	major Meneghiniani 1837		
Cyanobacteria	Lyngbya	major?		
Cyanobacteria	Lyngbya	sp.		
Cyanobacteria	Lyngbya	sp. 1?		
Cyanobacteria	Lyngbya	sp. 2		
Cyanobacteria	Lyngbya	sp. 3		
Cyanobacteria	Lyngbya	sp. 3?		
Cyanobacteria	Lyngbya	sp. 4		
Cyanobacteria	Lyngbya	sp. 5		
Cyanobacteria	Lyngbya?			
Cyanobacteria	Merismopedia	convoluta Brebisson in Kuetzing 1849		
Cyanobacteria	Merismopedia	elegans A. Braun in Kuetzing 1849		
Cyanobacteria	Merismopedia	glauca (Ehrenb.) Kuetzing 1849		
Cyanobacteria	Merismopedia	punctata Meyen 1839		
Cyanobacteria	Merismopedia	punctata Meyen?		
Cyanobacteria	Merismopedia	sp.		
Cyanobacteria	Merismopedia	sp. 2		
Cyanobacteria	Merismopedia	sp. 2?		
Cyanobacteria	Merismopedia	sp. 3		
Cyanobacteria	Microchaete	robinsonii J. Komarek 1994		
Cyanobacteria	Microchaete	robinsonii?		
Cyanobacteria	Microcystis	aeruginosa (Kuetz.) Kuetzing 1846		
Cyanobacteria	Microcystis	flos-aquae (Witt.) Kirchn. 1898		
Cyanobacteria	Microcystis	icthyoblabe Kuetzing 1845-9		
Cyanobacteria	Microcystis	incerta Lemmermann 1899		
Cyanobacteria	Microcystis	incerta?		
Cyanobacteria	Microcystis	sp.		
Cyanobacteria	Microcystis	sp. 2		
Cyanobacteria	Microcystis?			
Cyanobacteria	Nodularia	sphaerocarpa Bornet et Flahault 1888		
Cyanobacteria	Nodularia	spumigena Mertens et Bornet et Flahault 1888		
Cyanobacteria	Nostoc	sp.		
Cyanobacteria	Nostoc	sp. 2		
Cyanobacteria	Nostoc	sp. 4		
Cyanobacteria	Nostoc	sp. 4?		
Cyanobacteria	Nostoc	sp. 5		
Cyanobacteria	Nostoc	sp. 6		
Cyanobacteria	Nostoc	sp. 7		

Cyanobacteria	Nostoc	sp. 9		
Cyanobacteria	Nostoc	sp. 10?		
Cyanobacteria	Nostoc	sp. 11		
Cyanobacteria	Nostoc	sp. 12		
Cyanobacteria	Oscillatoria	amphibia C. A. Agardh 1827		
Cyanobacteria	Oscillatoria	amphibia?		
Cyanobacteria	Oscillatoria	angustissima West & West 1897		
Cyanobacteria	Oscillatoria	curviceps C. A Agardh 1824		
Cyanobacteria	Oscillatoria	formosa Bory 1827		
Cyanobacteria	Oscillatoria	formosa?		
Cyanobacteria	Oscillatoria	limosa (Roth) C. A. Agardh 1812		
Cyanobacteria	Oscillatoria	limosa?		
Cyanobacteria	Oscillatoria	princeps Vaucher 1803		
Cyanobacteria	Oscillatoria	sp.		
Cyanobacteria	Oscillatoria	sp. 1?		
Cyanobacteria	Oscillatoria	sp. 2		
Cyanobacteria	Oscillatoria	sp. 2?		
Cyanobacteria	Oscillatoria	sp. 3		
Cyanobacteria	Oscillatoria	sp. 3?		
Cyanobacteria	Oscillatoria	sp. 9		
Cyanobacteria	Oscillatoria	sp. 10		
Cyanobacteria	Oscillatoria	sp. 10?		
Cyanobacteria	Oscillatoria	sp. 12		
Cyanobacteria	Oscillatoria	sp. 12?		
Cyanobacteria	Oscillatoria	sp. 13		
Cyanobacteria	Oscillatoria	sp. 14		
Cyanobacteria	Oscillatoria	sp. 14?		
Cyanobacteria	Oscillatoria	sp. 15		
Cyanobacteria	Oscillatoria	sp. 16		
Cyanobacteria	Oscillatoria	sp. 17		
Cyanobacteria	Oscillatoria	sp. 18		
Cyanobacteria	Oscillatoria	sp. 18?		
Cyanobacteria	Oscillatoria	sp. 19		
Cyanobacteria	Oscillatoria	sp. 20		
Cyanobacteria	Oscillatoria	sp. 21		
Cyanobacteria	Oscillatoria	sp. 22		
Cyanobacteria	Phormidium	sp.		
Cyanobacteria	Phormidium	sp. 1		
Cyanobacteria	Phormidium	sp. 1?		
Cyanobacteria	Phormidium	sp. 2		
Cyanobacteria	Phormidium	sp. 2?		
Cyanobacteria	Phormidium	sp. 3		
Cyanobacteria	Phormidium	sp. 4		
Cyanobacteria	Phormidium	sp. 4?		
Cyanobacteria	Phormidium	sp. 5		
Cyanobacteria	Phormidium	sp. 5?		
Cyanobacteria	Phormidium?			
Cyanobacteria	Planktothrix	sp.		
Cyanobacteria	Schizothrix	friesii Gomont 1892		
Cyanobacteria	Spirulina	major Kuetzing 1843		
Cyanobacteria	Woronichinia	klingae Komarek et Komarkova-Legnerova 1992		
Eubacteria			Iron bacteria	

Euglenophyta	Colacium	vesiculosum Ehrenberg 1832		
Euglenophyta	Euglena	acus Ehrenberg 1838		
Euglenophyta	Euglena	acus?		
Euglenophyta	Euglena	adhaerens Matvienko 1938		
Euglenophyta	Euglena	agilis Carter 1856		
Euglenophyta	Euglena	agilis?		
Euglenophyta	Euglena	ehrenbergii Klebs 1883		
Euglenophyta	Euglena	ehrenbergii?		
Euglenophyta	Euglena	jirovecii Fott 1953		
Euglenophyta	Euglena	minuta?		
Euglenophyta	Euglena	oxyuris Smarda 1846		
Euglenophyta	Euglena	oxyuris var. minor Prescott 1944		
Euglenophyta	Euglena	oxyuris?		
Euglenophyta	Euglena	polymorpha Dangeard 1902		
Euglenophyta	Euglena	polymorpha?		
Euglenophyta	Euglena	rostrifera Johnson 1944		
Euglenophyta	Euglena	sanguinea Ehrenberg 1838		
Euglenophyta	Euglena	sociabilis Dangeard 1901		
Euglenophyta	Euglena	sociabilis?		
Euglenophyta	Euglena	spirogyra Ehrenberg 1838		
Euglenophyta	Euglena	spiroides var. annulata Gojdics 1953		
Euglenophyta	Euglena	tripteris (Duj.) Klebs 1883		
Euglenophyta	Euglena	tripteris?		
Euglenophyta	Euglena	truncata var. baculifera Thompson 1938		
Euglenophyta	Euglena	viridis Ehrenberg 1830		
Euglenophyta	Euglena	vivida Playfair?		
Euglenophyta	Euglena	sp.		
Euglenophyta	Euglena	sp. 2		
Euglenophyta	Euglena	sp. 2?		
Euglenophyta	Euglena	sp. 6		
Euglenophyta	Euglena	sp. 8		
Euglenophyta	Euglena	sp. 8?		
Euglenophyta	Euglena	sp. 9 (new sp.?)		
Euglenophyta	Euglena	sp. 10		
Euglenophyta	Euglena	sp. 10?		
Euglenophyta	Euglena	sp. 11 (new sp.?)		
Euglenophyta	Euglena?			
Euglenophyta	Lepocinclis	ovum?		
Euglenophyta	Lepocinclis	texta (Dujarden) Lemmermann 1901		
Euglenophyta	Lepocinclis	fusiformis (Carter) Lemmermann 1901		
Euglenophyta	Phacus	helikoides Pochman 1942		
Euglenophyta	Phacus	lismorensis Playfair 1921		
Euglenophyta	Phacus	longicauda (Ehrenb.) Dujardin 1841		
Euglenophyta	Phacus	longicauda?		
Euglenophyta	Phacus	orbicularis var. caudatus Skvortzow 1928		
Euglenophyta	Phacus	orbicularis var. caudatus?		
Euglenophyta	Phacus	pleuronectes (Mueller) Dujardin 1841		
Euglenophyta	Phacus	pyrum (Ehrenb.) Stein 1878		
Euglenophyta	Phacus	quinquemarginatus Jahn & Shawhan 1942		
Euglenophyta	Phacus	swirenkoi Skvortzow 1928		
Euglenophyta	Phacus	swirenkoi?		
Euglenophyta	Phacus	tortus (Lemm.) Skvortzow 1928		

Euglenophyta	Phacus	triqueter (Ehrenb.) Dujardin 1841		
Euglenophyta	Phacus	sp.		
Euglenophyta	Phacus	sp. 3		
Euglenophyta	Phacus	sp. 4		
Euglenophyta	Phacus	sp. 5		
Euglenophyta	Phacus	sp. 7		
Euglenophyta	Phacus	sp. 8		
Euglenophyta	Phacus	sp. 9		
Euglenophyta	Phacus	sp. 10		
Euglenophyta	Trachelomonas	armata (Ehrenb.) Stein 1883		
Euglenophyta	Trachelomonas	armata var. longispina (Playf.) Deflandre 1926		
Euglenophyta	Trachelomonas	armata var. novum?		
Euglenophyta	Trachelomonas	armata var?		
Euglenophyta	Trachelomonas	charkowiensis Swirenko ex Deflandre 1926		
Euglenophyta	Trachelomonas	dybowskii Drezepolski 1922		
Euglenophyta	Trachelomonas	dybowskii?		
Euglenophyta	Trachelomonas	erecta Skvortzow 1925		
Euglenophyta	Trachelomonas	granulosa Playfair 1916		
Euglenophyta	Trachelomonas	hispida var. punctata Lemmermann 1906		
Euglenophyta	Trachelomonas	hispida var. punctata?		
Euglenophyta	Trachelomonas	hispida var. truncata Lemmermann?		
Euglenophyta	Trachelomonas	robusta Swirenko 1914		
Euglenophyta	Trachelomonas	rotunda Swirenko 1914		
Euglenophyta	Trachelomonas	rotunda?		
Euglenophyta	Trachelomonas	similis Stokes 1890		
Euglenophyta	Trachelomonas	superba (Swir.) Deflandre 1926		
Euglenophyta	Trachelomonas	superba var. spinosa Prescott 1944		
Euglenophyta	Trachelomonas	superba var. swirenkiana Deflandre 1924		
Euglenophyta	Trachelomonas	sydneyensis Playfair 1916		
Euglenophyta	Trachelomonas	sydneyensis var. 1		
Euglenophyta	Trachelomonas	volvocina Ehrenberg 1833		
Euglenophyta	Trachelomonas	volvocina var. compressa Drezepolski 1925		
Euglenophyta	Trachelomonas	woycickii Koczwara 1915		
Euglenophyta	Trachelomonas	sp.		
Euglenophyta	Trachelomonas	sp. 1		
Euglenophyta	Trachelomonas	sp. 2		
Euglenophyta	Trachelomonas	sp. 4		
Euglenophyta	Trachelomonas	sp. 4?		
Euglenophyta	Trachelomonas	sp. 6		
Euglenophyta	Trachelomonas	sp. 6?		
Euglenophyta	Trachelomonas	sp. 7		
Euglenophyta	Trachelomonas	sp. 8?		
Euglenophyta	Trachelomonas	sp. 9		
Euglenophyta	Trachelomonas	sp. 10		
Euglenophyta	Trachelomonas	sp. 10?		
Euglenophyta	Trachelomonas	sp. 11		
Euglenophyta	Trachelomonas	sp. 11?		
Euglenophyta	Trachelomonas	sp. 12		
Euglenophyta	Trachelomonas	sp. 12?		
Euglenophyta	Trachelomonas	sp. 13		
Euglenophyta	Trachelomonas	sp. 14		
Euglenophyta	Trachelomonas	sp. 14?		

Euglenophyta			unknown flagellate	
Euglenophyta			green flagellate?	
Protozoa				
Family	**Genus**	**Species**	**Common Name**	
Ciliophora	Amphisella	sp.		
Ciliophora	Aspidisca	sp.		
Ciliophora	Aspidisca?			
Ciliophora	Chilodonella	sp.		
Ciliophora	Codonollopsis?			
Ciliophora	Coleps	hirta?		
Ciliophora	Coleps	sp.		
Ciliophora	Coleps	sp. 1		
Ciliophora	Coleps	sp. 2		
Ciliophora	Coleps?			
Ciliophora	Colpidium	sp.		
Ciliophora	Colpidium?			
Ciliophora	Condylostoma	sp.		
Ciliophora	Cothurnia	sp.		
Ciliophora	Cyclidium	sp.		
Ciliophora	Cyclidium?			
Ciliophora	Cytophosis?			
Ciliophora	Dileptus	sp.		
Ciliophora	Dileptus			
Ciliophora	Enchelys	sp.		
Ciliophora	Epistylis	sp.		
Ciliophora	Euplotes	sp.		
Ciliophora	Frontonia	sp.		
Ciliophora	Frontonia			
Ciliophora	Frontonia?			
Ciliophora	Glaucoma	sp.		
Ciliophora	Halteria sp.	sp.		
Ciliophora	Holosticha	sp. 2		
Ciliophora	Homalozoon?			
Ciliophora	Lacrymaria	sp.		
Ciliophora	Litonotus sp.	sp.		
Ciliophora	Litonotus?			
Ciliophora	Loxodes			
Ciliophora	Loxophyllum	sp.		
Ciliophora	Loxophyllum?			
Ciliophora	Metopus	sp.		
Ciliophora	Nassula	sp.		
Ciliophora	Nolandia	nolandia?		
Ciliophora	Opercularia	sp.		
Ciliophora	Oxytricha	sp.		
Ciliophora	Oxytricha	sp. 2		
Ciliophora	Paramecium	bursaria (Ehrenb.) Focker 1836		
Ciliophora	Paramecium	bursaria?		
Ciliophora	Paramecium	caudatum Ehrenberg 1838		
Ciliophora	Paramecium	caudatum?		
Ciliophora	Paramecium	sp.		
Ciliophora	Paramecium	sp. 1		

Ciliophora	Paramecium?			
Ciliophora	Paruroleptus?			
Ciliophora	Platycola	sp. 2		
Ciliophora	Platynematum	sp.		
Ciliophora	Prorodon	sp.		
Ciliophora	Pyxicola	sp.		
Ciliophora	Pyxicola	sp. 1		
Ciliophora	Rhabdostyla	sp.		
Ciliophora	Spirostomum	sp.		
Ciliophora	Spirostomum	sp. 1		
Ciliophora	Steinia	sp.		
Ciliophora	Stenostomum	sp.		
Ciliophora	Stentor	sp.		
Ciliophora	Stentor?			
Ciliophora	Strongylidium	sp.		
Ciliophora	Stylonychia	sp.		
Ciliophora	Stylonychia	sp. 1		
Ciliophora	Tachysoma	sp.		
Ciliophora	Urocentrum	sp. 1		
Ciliophora	Uroleptus	sp.		
Ciliophora	Urostyla	sp.		
Ciliophora	Vaginicola	sp.		
Ciliophora	Vorticella	campanula Ehrenberg 1831		
Ciliophora	Vorticella	sp.		
Ciliophora	Zoothamnion	sp.		
Ciliophora			unknown genus	
Ciliophora			dividing cell	
Ciliophora			small ciliate	
Ciliophora			small ciliates	
Ciliophora			ciliate	
Ciliophora			large ciliate	
Ciliophora			telotroch larvae	
Ciliophora			ciliates on copepod	
Ciliophora			elliptical ciliate	
Pyrrophyta	Ceratium	sp.		
Pyrrophyta	Glenodinium	sp.		
Pyrrophyta	Glenodinium?			
Pyrrophyta	Gymnodinium?			
Pyrrophyta	Nematodinium	sp.		
Sarcodina	Acanthamoeba	sp.		
Sarcodina	Actinosphaerium	sp.		
Sarcodina	Amoeba	radiosa (disputed taxon)		
Sarcodina	Amoeba	vespertilio Penard 1902		
Sarcodina	Amoeba	vespertilio?		
Sarcodina	Amoeba	sp.		
Sarcodina	Arcella	vulgaris Ehrenberg 1830		
Sarcodina	Arcella	sp.		
Sarcodina	Arcella	sp. 3		
Sarcodina	Arcella	sp. 4		
Sarcodina	Arcella?			
Sarcodina	Biomyxa	sp.		
Sarcodina	Centropyxis	aculeata (Ehrenb.) Stein 1859		

Sarcodina	Centropyxis	arcelloides Penard 1902		
Sarcodina	Centropyxis	sp.		
Sarcodina	Centropyxis	sp. 1		
Sarcodina	Centropyxis	sp. 1?		
Sarcodina	Centropyxis?			
Sarcodina	Cochliopodium	bilimbosum Auerbach 1856		
Sarcodina	Difflugia	acuminata Ehrenberg 1830		
Sarcodina	Difflugia	corona Wallich 1864		
Sarcodina	Difflugia	lebes Penard 1899		
Sarcodina	Difflugia	lobostoma Leidy 1879		
Sarcodina	Difflugia	oblonga Ehrenberg 1832		
Sarcodina	Difflugia	oblonga?		
Sarcodina	Difflugia	sp.		
Sarcodina	Difflugia	sp. 1		
Sarcodina	Difflugia	sp. 2		
Sarcodina	Difflugia	sp. 2?		
Sarcodina	Difflugia	sp. 3		
Sarcodina	Euglypha	sp.		
Sarcodina	Hartmanella	sp.		
Sarcodina	Hartmanella	sp. 1		
Sarcodina	Hartmanella	sp. 2		
Sarcodina	Mayorella	sp. 1		
Sarcodina	Mayorella	sp. 1?		
Sarcodina	Mayorella	sp. 2		
Sarcodina	Mayorella	sp. 4		
Sarcodina	Mayorella	sp. 5		
Sarcodina	Mayorella	sp. 6		
Sarcodina	Mayorella	sp. 7		
Sarcodina	Mayorella	sp. 8		
Sarcodina	Nebela	collaris (Ehrenberg 1848) Leidy 1879		
Sarcodina	Nebela	sp.		
Sarcodina	Nuclearia	sp.		
Sarcodina	Pelomyxa	sp.		
Sarcodina	Pyxidicula	operculata Ehrenberg 1838		
Sarcodina	Vannella	sp.		
Sarcodina			unknown ameba	
Sarcodina			unknown heliozoan	
Suctoria	Tokaphyra?			
Zoomastigophora	Ancyromonas	contorta Lemmermann?		
Zoomastigophora	Anisonema?			
Zoomastigophora	Astasia	klebsii Lemmermann 1910		
Zoomastigophora	Astasia	sp.		
Zoomastigophora	Astasia?			
Zoomastigophora	Bodo?			
Zoomastigophora	Cryptochrysis?			
Zoomastigophora	Entosiphon	sp.		
Zoomastigophora	Entosiphon?			
Zoomastigophora	Khawkinea	sp. 1		
Zoomastigophora	Mastigamoeba	sp.		
Zoomastigophora	Peranema	sp.		
Zoomastigophora	Peranema?			
Zoomastigophora	Petalomonas			

Zoomastigophora	Petalomonas?			
Zoomastigophora	Salpingoeca	sp.		
Zoomastigophora	Unknown genus			
Zoomastigophora			colorless flagellate	
Zoomastigophora			small flagellates	
Intertebrata				
Family	**Genus**	**Species**	**Common Name**	**State Status**
Bryozoa			statoblasts	
Cladocera	Alona	sp.		
Cladocera	Alonella	nana Baird 1850		
Cladocera	Bosmina	longirostris O. F. Mueller 1785		
Cladocera	Bosmina	sp.		
Cladocera	Ceriodaphnia	megalops Sars 1861		
Cladocera	Ceriodaphnia	reticulata Jurine 1820		
Cladocera	Ceriodaphnia	rotunda Sars 1862		
Cladocera	Chydorus	sphaericus O. F. Mueller 1785		
Cladocera	Chydorus	sp.		
Cladocera	Daphnia	schodleri Sars 1862		
Cladocera	Kurzia	sp.		
Cladocera	Kurzia	sp. 1		
Cladocera	Kurzia	sp. 2		
Cladocera	Macrothrix	rosea Jurine 1820		
Cladocera	Pleuroxus	denticulatus Birge 1878		
Cladocera	Simocephalus	serrulatus Koch 1841		
Cladocera	Simocephalus	vetulus Schodler 1858		
Cnidaria	Chlorohydra	viridissima Pallas 1766		
Copepoda			adult copepods	
Copepoda			nauplii	
Copepoda			harpacticoid copepods	
Ostracoda	Physocypria	sp.		
Gastropoda				
Gastrotricha	Aspidiophorus			
Gastrotricha	Chaetonotus	sp.		
Gastrotricha	Chaetonotus	sp. 1		
Gastrotricha	Chaetonotus?			
Gastrotricha	Lepiderma	sp.		
Gastrotricha	Polymerurus?			
Gastrotricha	Unknown genus			
Hydrocarina				
Insecta			caddisfly larva	
Insecta			dipteran larva	
Insecta			midge larva	
Insecta			mosquito larva	
Insecta			unknown insect larva	
Nematoda				
Oligochaeta	Aeolosoma sp.			
Oligochaeta	Dero sp.			
Oligochaeta	Nais?			
Oligochaeta	Stylaria sp.			
Oligochaeta	Stylaria?			
Oligochaeta	Unknown genus			

Platyhelminthes				
Porifera				
Rotifera	Asplanchna?			
Rotifera	Brachionus	quadridentata Hermann 1783		
Rotifera	Brachionus	variabilis?		
Rotifera	Brachionus	sp.		
Rotifera	Brachionus	sp. 1		
Rotifera	Cephalodella	sp.		
Rotifera	Colurella	sp.		
Rotifera	Dicranophorus .	sp		
Rotifera	Dicranophorus?			
Rotifera	Enteroplea	sp.		
Rotifera	Enteroplea?			
Rotifera	Euchlanis	sp.		
Rotifera	Euchlanis	sp. 1		
Rotifera	Euchlanis?			
Rotifera	Lecane	luna O. F. Mueller 1876		
Rotifera	Lecane	luna?		
Rotifera	Limnias	sp.		
Rotifera	Monostyla	sp.		
Rotifera	Mytillina	sp.		
Rotifera	Notommata	sp.		
Rotifera	Notommata?			
Rotifera	Philodina	sp.		
Rotifera	Philodina?			
Rotifera	Rotaria	neptunia Ehrenberg 1832		
Rotifera	Rotaria	sp.		
Rotifera	Trichocerca	bicristata?		
Rotifera	Unknown genus			
Tardigrada				
Amphibia				
Family	**Genus**	**Species**	**Common Name**	**State Status**
Ambystomatidae	Ambystoma	tigrinum	Tiger Salamander	
Bufonidae	Bufo	americanus	American Toad	
Hylidae	Acris	crepitans	Cricket Frog	
Hylidae	Hyla	chrysoscelis	Cope's Gray Treefrog	
Hylidae	Hyla	sp.	Treefrog Species	
Hylidae	Hyla	versicolor	Gray Treefrog	
Hylidae	Pseudacris	triseriata	Western Chorus Frog	
Ranidae	Rana	blairi	Plains Leopard Frog	
Ranidae	Rana	catesbeiana	Bullfrog	
Ranidae	Rana	clamitans	Green Frog	
Ranidae	Rana	pipiens	Northern Leopard Frog	
Aves				
Family	**Genus**	**Species**	**Common Name**	**State Status**
Accipitridae	Accipiter	striatus	Sharp-shinned Hawk	
Accipitridae	Buteo	jamaicencis	Red-Tailed Hawk	
Accipitridae	Buteo	lineatus	Red-shouldered Hawk	Endangered

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Accipitridae	Circus	cyaneus	Northern Harrier	Endangered
Alaudidae	Eremophila	alpestris	Horned Lark	
Alcedinidae	Ceryle	alcyon	Belted Kingfisher	
Anatidae	Aix	sponsa	Wood Duck	
Anatidae	Anas	acuta	Northern Pintail	
Anatidae	Anas	americana	American Widgeon	
Anatidae	Anas	clypeata	Northern Shoveler	
Anatidae	Anas	crecca	Green-winged Teal	
Anatidae	Anas	discors	Blue-winged Teal	
Anatidae	Anas	platyrhynchos	Mallard	
Anatidae	Anas	strepera	Gadwall	
Anatidae	Athya	affinis	Lesser Scaup	
Anatidae	Aythya	americana	Redhead	
Anatidae	Aythya	collaris	Ringneck Duck	
Anatidae	Aythya	sp.	Scaup	
Anatidae	Branta	canadensis	Canada Goose	
Anatidae	Bucephala	albeola	Bufflehead	
Anatidae	Bucephala	clangula	Common Goldeneye	
Anatidae	Chen	caerulescens	Snow Goose	
Anatidae	Cygnus	buccinator	Trumpeter Swan	
Anatidae	Lophodytes	cucullatus	Hooded Merganser	
Anatidae	Lophodytes	cucullatus	Hooded Merganser	
Anatidae	Mergus	merganser	Common Merganser	
Anatidae	Oxyura	jamaicensis	Ruddy Duck	
Apodidae	Chaetura	pelagica	Chimney Swift	
Ardeidae	Botaurus	lentiginosus	American Bittern	
Ardeidae	Butorides	virescens	Green Heron	
Ardeidae	Nycticorax	nycticorax	Black-crowned Night Heron	
Bombycillidae	Bombycilla	cedrorum	Cedar Waxwing	
Cathartidae	Cathartes	aurua	Turkey Vulture	
Charadriidae	Charadrius	vociferous	Killdeer	
Ciconidae	Ardea	herodius	Great Blue Heron	
Ciconiidae	Casmerodius	albus	Great Egret	
Ciconiidae	Ixobrychus	exilis	Least Bittern	
Columbidae	Columba	livia	Rock Pigeon	
Columbidae	Zenaida	macroura	Mourning Dove	
Corvidae	Corvus	brachyrhynchos	American Crow	
Corvidae	Cyanocitta	cristata	Blue Jay	
Cuculidae	Coccyzus	americanus	Yellow-billed Cuckoo	
Cuculidae	Coccyzus	erythropthalmus	Black-billed Cuckoo	
Emberizidae	Ammodramus	savannarum	Grasshopper Sparrow	
Emberizidae	Cardinalis	cardinalis	Northern Cardinal	
Emberizidae	Melospiza	georgiana	Swamp Sparrow	
Emberizidae	Melospiza	lincolnii	Lincoln's Sparrow	
Emberizidae	Melospiza	melodia	Song Sparrow	
Emberizidae	Passerculus	sandwichensis	Savannah Sparrow	
Emberizidae	Passerina	cyanea	Indigo Bunting	
Emberizidae	Pheucticus	ludovicianus	Rose-breasted Grosbeak	
Emberizidae	Pipilo	erythrophthalmus	Rufous-sided Towhee	
Emberizidae	Spiza	americana	Dickcissel	
Emberizidae	Spizella	arborea	American Tree Sparrow	
Emberizidae	Spizella	passerina	Chipping Sparrow	

Emberizidae	Spizella	pusilla	Field Sparrow	
Falconidae	Pandion	halieatus	Osprey	
Fringillidae	Carduelis	tristis	American Goldfinch	
Gruidae	Grus	canadensis	Sandhill Crane	
Hirundinidae	Hirundo	pyrrhonota	Cliff Swallow	
Hirundinidae	Hirundo	rustica	Barn Swallow	
Hirundinidae	Iridoprocne	bicolor	Tree Swallow	
Hirundinidae	Petrochelidon	pyrrhonota	Cliff Swallow	
Hirundinidae	Riparia	riparia	Bank Swallow	
Hirundinidae	Stelgidopteryx	ruficollis	Northern Rough-winged Swallow	
Hirundinidae	Tachycineta	bicolor	Tree Swallow	
Icteridae	Agelaius	phoeniceus	Red-winged Blackbird	
Icteridae	Dolichonyx	oryzivorus	Bobolink	
Icteridae	Icterus	galbula	Baltimore Oriole	
Icteridae	Icterus	spurius	Orchard Oriole	
Icteridae	Molothrus	ater	Brownheaded Cowbird	
Icteridae	Quiscalus	quiscula	Common Grackle	
Icteridae	Sturnella	magna	Eastern Meadowlark	
Icteridae	Sturnella	neglecta	Western Meadowlark	
Icteridae	Xanthocephalus	xanthocephalus	Yellow-headed Blackbird	
Laridae	Sterna	hirundo	Common Tern	
Mimidae	Dumetella	carolinensis	Gray Catbird	
Mimidae	Mimus	polyglottos	Northern Mockingbird	
Mimidae	Toxostoma	rufum	Brown Thrasher	
Paridae	Parus	atricapillus	Black-capped Chickadee	
Paridae	Parus	bicolor	Tufted Titmouse	
Parulidae	Dendroica	petechia	Yellow Warbler	
Parulidae	Geothlypis	trichas	Common Yellowthroat	
Parulidae	Icteria	virens	Yellow-breasted Chat	
Parulidae	Setophaga	ruticilla	American Redstart	
Passeridae	Passer	domesticus	House Sparrow	
Phalacrocoracidae	Phalacrocorax	auritus	Double-breasted Comorant	
Phasianidae	Meleagris	gallopavo	Wild Turkey	
Phasianidae	Phasianus	colchicus	Ring-necked Pheasant	
Picidae	Melanerpes	erythrocephalus	Red-headed Woodpecker	
Picidae	Picoides	pubescens	Downy Woodpecker	
Piciformes	Colaptes	auratus	Northern Flicker	
Podicipedidae	Podiceps	auritus	Horned Grebe	
Podicipedidae	Podilymbus	podiceps	Pied-billed Grebe	
Rallidae	Fulica	americana	American Coot	
Rallidae	Porzana	carolina	Sora	
Rallidae	Rallus	limicola	Virginia Rail	
Scolopacidae	Actitis	macularia	Spotted Sandpiper	
Scolopacidae	Calidris	mauri	Western Sandpiper	
Scolopacidae	Calidris	melanotos	Pectoral Sandpiper	
Scolopacidae	Calidris	minutilla	Least Sandpiper	
Scolopacidae	Calidris	pusilla	Semipalmated Sandpiper	
Scolopacidae	Gallinago	gallinago	Common Snipe	
Scolopacidae	Limnodromus	griseus	Short-billed Dowitcher	
Scolopacidae	Limnodromus	scolopaceus	Long-billed Dowitcher	
Scolopacidae	Scolopax	minor	American Woodcock	
Scolopacidae	Tringa	flavipes	Lesser Yellowlegs	

Sittidae	Sitta	carolinensis	White-breasted Nuthatch	
Sturnidae	Sturnus	vulgaris	European Starling	
Sylviidae	Polioptila	caerulea	Blue-gray Gnatcatcher	
Trochilidae	Archilochus	colubris	Ruby-throated Hummingbird	
Troglodytidae	Cistothorus	palustris	Marsh Wren	
Troglodytidae	Cistothorus	platensis	Sedge Wren	
Troglodytidae	Thryothorus	ludovicianus	Carolina Wren	
Troglodytidae	Troglodytes	aedon	House Wren	
Turdidae	Catharus	ustulatus	Swainson's Thrush	
Turdidae	Hylocichla	mustelina	Wood Thrush	
Turdidae	Sialia	sialius	Eastern Bluebird	
Turdidae	Turdus	migratorius	American Robin	
Tyrannidae	Contupus	virens	Eastern Wood Pewee	
Tyrannidae	Empidonax	traillii	Willow Flycatcher	
Tyrannidae	Empindonax	minimus	Least Flycatcher	
Tyrannidae	Myiarchus	crinitus	Great Crested Flycatcher	
Tyrannidae	Sayornis	phoebe	Eastern Phoebe	
Tyrannidae	Tyrannus	tyrannus	Eastern Kingbird	
Vireonidae	Vireo	flavifrons	Yellow-throated Vireo	
Vireonidae	Vireo	gilvus	Warbling Vireo	
Vireonidae	Vireo	bellii	Bell's Vireo	
Vireonidae	Vireo	olivaceus	Red-eyed Vireo	
Lepidoptera				
Family	**Genus**	**Species**	**Common Name**	**State Status**
Hesperiidae	Anatrytone	logan	Delaware Skipper	
Hesperiidae	Ancyloxypha	numitor	Least Skipper	
Hesperiidae	Atalopedes	campestris	Sachem	
Hesperiidae	Epargyreus	clarus	Silver-spotted Skipper	
Hesperiidae	Erynnis	baptisiae	Wild Indigo Duskywing	Special Concern
Hesperiidae	Erynnis	horatius	Horace's Duskywing	
Hesperiidae	Euphyes	bimacula	Two-spotted Skipper	Special Concern
Hesperiidae	Euphyes	conspicua	Black Dash	
Hesperiidae	Euphyes	dion	Dion Skipper	Special Concern
Hesperiidae	Euphyes	vestris	Dun Skipper	
Hesperiidae	Hylephila	phyleus	Fiery Skipper	
Hesperiidae	Pholisora	catullus	Common Sootywing	
Hesperiidae	Poanes	hobomok	Hobomok Skipper	
Hesperiidae	Polites	coras	Peck's Skipper	
Hesperiidae	Polites	mystic	Long Dash	
Hesperiidae	Polites	origenes	Crossline Skipper	
Hesperiidae	Polites	themistocles	Tawny-edged Skipper	
Hesperiidae	Pyrgus	communis	Common Checkered Skipper	
Hesperiidae	Thymelicus	lineola	European Skipper	
Lycaenidae	Celastrina	ladon	Spring Azure	
Lycaenidae	Celastrina	neglecta	Summer Azure	
Lycaenidae	Everes	comyntas	Eastern Tailed Blue	
Lycaenidae	Hemiargus	isola	Reakirt's Blue	
Lycaenidae	Lycaena	dione	Gray Copper	
Lycaenidae	Lycaena	hyllus	Bronze Copper	
Lycaenidae	Phyciodes	tharos	Pearl Crescent	

Lycaenidae	Satyrium	titus	Coral Hairstreak	
Lycaenidae	Strymon	melinus	Gray Hairstreak	
Nymphalidae	Asterocampa	celtis	Hackberry Emporer	
Nymphalidae	Boloria	bellona	Meadow Fritillary	
Nymphalidae	Boloria	selene	Silver-bordered Fritillary	
Nymphalidae	Cercyonis	pegala	Common Wood Nymph	
Nymphalidae	Chlosyne	gorgone	Gorgone Checkerspot	
Nymphalidae	Chlosyne	nycteis	Silvery Checkerspot	
Nymphalidae	Danaus	plexippus	Monarch	
Nymphalidae	Enodia	anthedon	Northern Pearly-eye	
Nymphalidae	Euptoieta	claudia	Variegated Fritillary	
Nymphalidae	Junonia	coenia	Buckeye	
Nymphalidae	Libytheana	carinenta	American Snout	
Nymphalidae	Limenitis	a. astyanax	Red-spotted Purple	
Nymphalidae	Limenitis	archippus	Viceroy	
Nymphalidae	Megisto	cymela	Little Wood Satyr	
Nymphalidae	Nymphalis	antiopa	Mourning Cloak	
Nymphalidae	Polygonia	comma	Eastern Comma	
Nymphalidae	Polygonia	interrogationis	Question Mark	
Nymphalidae	Satyrodes	eurydice	Eyed Brown	
Nymphalidae	Speyeria	aphrodite	Aphrodite Fritillary	
Nymphalidae	Speyeria	cybele	Great Spangled Fritillary	
Nymphalidae	Speyeria	idalia	Regal Fritillary	Special Concern
Nymphalidae	Vanessa	atalanta	Red Admiral	
Nymphalidae	Vanessa	cardui	Painted Lady	
Nymphalidae	Vanessa	virginiensis	American Lady	
Papilionidae	Papilio	cresphontes	Giant Swallowtail	
Papilionidae	Papilio	glaucus	Eastern Tiger Swallowtail	
Papilionidae	Papilio	polyxenes	Black Swallowtail	
Pieridae	Colias	eurytheme	Orange Sulphur	
Pieridae	Colias	philodice	Clouded Sulphur	
Pieridae	Eurema	lisa	Little Yellow	
Pieridae	Nathalis	iole	Dainty Sulphur	
Pieridae	Phoebis	sennae	Cloudless Sulphur	
Pieridae	Pieris	rapae	Cabbage White	
Pieridae	Pontia	protodice	Checkered White	
Mammalia				
Family	**Genus**	**Species**	**Common Name**	**State Status**
Arvicolidae	Ondatra	zibethicus	Muskrat	
Canidae	Vulpes	vulpes	Red Fox	
Castoridae	Castor	canadensis	Beaver	
Cervidae	Odocoileus	virginianus	White-tailed Deer	
Cricetidae	Microtus	ochrogaster	Prairie Vole	
Cricetidae	Microtus	pennsylvanicus	Meadow Vole	
Cricetidae	Peromyscus	leucopus	White-footed Mouse	
Cricetidae	Peromyscus	maniculatus	Deer Mouse	
Cricetidae	Peromyscus	spp.	Deer/White-footed Mouse	
Cricetidae	Reithrodontomys	megalotis	Western Harvest Mouse	
Felidae	Felis	domesticus	Domestic Cat	
Felidae	Felis	rufus	Bobcat	

Geomyidae	Geomys	bursarius	Plains Pocket Gopher	
Leporidae	Sylvilagus	floridanus	Eastern Cottontail Rabbit	
Muridae	Mus	musculus	House Mouse	
Mustelidae	Mustela	frenata	Long-tailed Weasel	
Mustelidae	Mustela	nivalis	Least Weasel	
Mustelidae	Mustela	vison	Mink	
Mustelidae	Taxidea	taxus	Badger	
Procyonidae	Procyon	lotor	Raccoon	
Sciuridae	Spermophilus	tridecemlineatus	Thirteen-lined Ground Squirrel	
Sciuridae	Tamias	striatus	Eastern Chipmunk	
Soricidae	Blarina	brevicauda	Short-tailed Shrew	
Soricidae	Sorex	cinereus	Masked Shrew	
Zapodidae	Zapus	hudsonicus	Meadow Jumping Mouse	
Reptilia				
Family	**Genus**	**Species**	**Common Name**	**State Status**
Chelydridae	Chelydra	serpentina	Snapping Turtle	
Emydidae	Chrysemys	picta	Painted Turtle	
Colubridae	Coluber	constrictor	Racer	
Colubridae	Elaphe	vulpina	Fox Snake	
Emydidae	Emydoidea	blandingii	Blanding's Turtle	Threatened
Colubridae	Nerodia	grahami	Graham's Crayfish Snake	
Colubridae	Nerodia	sipedon	Northern Water Snake	
Colubridae	Nerodia	sp.	Water Snake spp.	
Colubridae	Opheodrys	vernalis	Smooth Green Snake	Special Concern
Viperidae	Sistrurus	catenatus	Eastern Massasauga Rattlesnake	Endangered
Colubridae	Storeria	dekayi	Brown Snake	
Colubridae	Storeria	occipitomaculata	Northern Redbelly Snake	
Colubridae	Thamnophis	proximus	Western Ribbon Snake	
Colubridae	Thamnophis	radix	Plains Garter Snake	
Colubridae	Thamnophis	sirtalis	Eastern Garter Snake	
Colubridae	Thamnophis	sirtalis parietalis	Red-sided Garter Snake	
Flora				
Family	**Genus**	**Species**	**Common Name**	**State Status**
Aceraceae	Acer	negundo	Box elder	
Aceraceae	Acer	saccharinum	Silver maple	
Aizoaceae	Mollugo	verticillata	Carpetweed	
Alismataceae	Alisma	subcordatum	Southern water plantain	
Alismataceae	Alisma	triviale	Northern water plantain	
Alismataceae	Sagittaria	graminea	Grass-leaved arrowhead	
Alismataceae	Sagittaria	brevirostra	Short-beaked arrowleaf	
Alismataceae	Sagittaria	latifolia	Common arrowhead	
Alismataceae	Sagittaria	rigida	Stiff arrowhead	
Amaranthaceae	Amaranthus	rudis	Tamarisk waterhemp	
Anacardiaceae	Toxicodendron	radicans	Poison ivy	

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Anachardiaceae	Rhus	glabra	Smooth sumac	
Apiaceae	Chaerophyllum	procumbens	Chervil	
Apiaceae	Cicuta	bulbifera	Bulblet water hemlock	
Apiaceae	Cicuta	maculata	Watera hemlock	
Apiaceae	Cryptotaenia	canadensis	Honewort	
Apiaceae	Daucus	carota	Queen Anne's lace	
Apiaceae	Eryngium	yuccifolium	Rattlesnake master	
Apiaceae	Heracleum	lanatum	Cow parsnip	
Apiaceae	Osmorhiza	longistylis	Anise root	
Apiaceae	Pastinaca	sativa	Wild parsnip	
Apiaceae	Sanicula	canadensis	Black snakeroot	
Apiaceae	Sanicula	gregaria	Common snakeroot	
Apiaceae	Sium	suave	Water parsnip	
Apiaceae	Zizia aurea	americanum	Golden alexanders	
Apiaceae				
Apocynaceae	Apocynum	cannabinum	Indian hemp	
Apocynaceae	Apocynum	sibiricum	Indian hemp	
Araceae	Acorus	calamus	Sweetflag	
Asclepiadaceae	Asclepias	incarnata	Swamp milkweed	
Asclepiadaceae	Asclepias	sullivantii	Prairie milkweed	
Asclepiadaceae	Asclepias	syriaca	Common milkweed	
Asclepiadaceae	Asclepias	tuberosa	Butterfly weed	
Asclepiadaceae	Asclepias	verticillata	Whorled milkweed	
Asclepiadaceae	Cynanchum	laeve	Bluevine	
Aspleniaceae	Onoclea	sensibilis	Sensitive fern	
Aspleniaceae	Thelypteris	palustris	Marsh fern	
Asteraceae	Achillea	millefolium	Yarrow	
Asteraceae	Ambrosia	artemisiifolia	Common ragweed	
Asteraceae	Ambrosia	trifida	Giant ragweed	
Asteraceae	Antennaria	neglecta	Pussytoes	
Asteraceae	Arctium	minus	Common burdock	
Asteraceae	Artemisia	ludoviciana	White sage	
Asteraceae	Aster	ericoides	Heath aster, frost weed	
Asteraceae	Aster	lanceolatus	Eastern lined aster	
Asteraceae	Aster	lateriflorus	Side-flowered aster	
Asteraceae	Aster	novae-angliae	New England aster	
Asteraceae	Aster	ontarionis	Ontario aster	
Asteraceae	Aster	paniculatus	Eastern lined aster	
Asteraceae	Aster	pilosus	Hairy aster	
Asteraceae	Aster	praealtus	Willow aster	
Asteraceae	Aster	puniceus	Swamp aster	
Asteraceae	Aster	sagittifolius	Arrow-leaved aster	

Asteraceae	Aster	sericeus	Silky aster	
Asteraceae	Bidens	cernua	Nodding bur marigold	
Asteraceae	Bidens	comosa	Strawstem bidens	
Asteraceae	Bidens	frondosa	Beggar-ticks	
Asteraceae	Bidens	polylepis	Ozark tickseed sunflower	
Asteraceae	Bidens	vulgata	Tall beggar-ticks	
Asteraceae	Boltonia	asteroides	False aster	
Asteraceae	Brickellia	eupatorioides	False boneset	
Asteraceae	Cacalia	plantaginea	Prairie Indian plaintain	
Asteraceae	Carduus	nutans	Musk thistle	
Asteraceae	Cirsium	altissimum	Tall thistle	
Asteraceae	Cirsium	arvense	Canada thistle	
Asteraceae	Cirsium	discolor	Field thistle	
Asteraceae	Cirsium	vulgare	Bull thistle	
Asteraceae	Conyza	canadensis	Horseweed, mule tail	
Asteraceae	Coreopsis	tinctoria	Golden coreopsis	
Asteraceae	Coreopsis	tripteris	Tall tickseed	
Asteraceae	Dyssodia	papposa	Fetid marigold	
Asteraceae	Erigeron	annuus	Annual fleabane	
Asteraceae	Erigeron	strigosus	Daisy fleabane	
Asteraceae	Eupatorium	altissimum	Tall thoroughwort	
Asteraceae	Eupatorium	maculatum	Spotted Joe-pye-weed	
Asteraceae	Eupatorium	perfoliatum	Boneset	
Asteraceae	Eupatorium	rugosum	White snakeroot	
Asteraceae	Eupatorium	serotinum	Late boneset	
Asteraceae	Euthamia	graminifolia	Grass-leaved goldenrod	
Asteraceae	Gaillardia	pulchella	Blanket flower, rose-ring gaillardia	
Asteraceae	Gnaphalium	obtusifolium	Everlasting	
Asteraceae	Helenium	autumnale	Sneezeweed	
Asteraceae	Helianthus	grosseserratus	Saw-tooth sunflower	
Asteraceae	Helianthus	maximiliani	Maximilian's sunflower	
Asteraceae	Helianthus	rigidus	Prairie sunflower	
Asteraceae	Helianthus	tuberosus	Jerusalem artichoke	
Asteraceae	Heliopsis	helianthoides	Ox-eye	
Asteraceae	Krigia	biflora	False dandelion	
Asteraceae	Lactuca	canadensis	Wild lettuce	
Asteraceae	Lactuca	floridana	Blue lettuce	
Asteraceae	Lactuca	serriola	Prickly lettuce	
Asteraceae	Lactuca	sp.		
Asteraceae	Liatris	aspera	Blazing star	
Asteraceae	Liatris	pycnostachya	Prairie blazing star	
Asteraceae	Ratibida	pinnata	Gray-headed coneflower	
Asteraceae	Rudbeckia	hirta	Black-eyed Susan	
Asteraceae	Rudbeckia	laciniata	Tall coneflower	
Asteraceae	Rudbeckia	subtomentosa	Fragrant coneflower	
Asteraceae	Rudbeckia	triloba	Brown-eyed Susan	
Asteraceae	Senecio	aureus	Golden ragwort	

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Asteraceae	Senecio	pauperculus	Prairie ragwort	
Asteraceae	Senecio	plattensis	Prairie ragwort	
Asteraceae	Silphium	integrifolium	Rosinweed	
Asteraceae	Silphium	laciniatum	Compass plant	
Asteraceae	Silphium	perfoliatum	Cup plant	
Asteraceae	Solidago	canadensis	Tall goldenrod	
Asteraceae	Solidago	gigantea	Smooth goldenrod	
Asteraceae	Solidago	rigida	Stiff goldenrod	
Asteraceae	Solidago	speciosa	Showy goldenrod	
Asteraceae	Sonchus	arvensis	Perennial sow thistle	
Asteraceae	Sonchus	asper	Spiny-leaved sow thistle	
Asteraceae	Taraxacum	officinale	Common dandelion	
Asteraceae	Tragopogon	dubius	Goat's-beard	
Asteraceae	Vernonia	baldwinii	Baldwin's ironweed	
Asteraceae	Vernonia	fasciculata	Ironweed	
Asteraceae	Xanthium	strumarium	Cocklebur	
Balsaminaceae	Impatiens	capensis	Spotted touch-me-not	
Berberidaceae	Podophyllum	peltatum	Mayapple	
Betulaceae	Betula	nigra	River birch	
Boraginaceae	Hackelia	virginiana	Stickseed	
Boraginaceae	Lithospermum	canescens	Hoary puccoon	
Boraginaceae	Lithospermum	incisum	Fringed puccoon	
Boraginaceae	Onosmodium	molle	False gromwell	
Brassicaceae	Alliaria	petiolata	Garlic mustard	
Brassicaceae	Barbarea	vulgaris	Yellow rocket	
Brassicaceae	Capsella	bursa-pastoris	Shepherd's purse	
Brassicaceae	Cardamine	bulbosa	Spring cress	
Brassicaceae	Descurainia	pinnata	Tansy mustard	
Brassicaceae	Hesperis	matronalis	Dame's rocket	
Brassicaceae	Lepidium	campestre	Field cress	
Brassicaceae	Lepidium	densiflorum	Peppergrass	
Brassicaceae	Lepidium	virginicum	Poor-man's pepper	
Brassicaceae	Rorippa	palustris	Marsh cress	
Brassicaceae	Rorippa	sessiliflora	Sessile-flowered cress	
Brassicaceae	Rorripa	sp.		
Brassicaceae	Sisymbrium	loeselii	Tall hedge mustard	
Brassicaceae	Thlaspi	arvense	Penny cress	
Brassicaceae				
Campanulaceae	Campanula	americana	Tall bellflower	
Campanulaceae	Campanula	aparinoides	Marsh bellflower	
Campanulaceae	Lobelia	cardinalis	Cardinal flower	
Campanulaceae	Lobelia	siphilitica	Great lobelia	
Campanulaceae	Triodanis	perfoliata	Venus' looking-glass	
Caprifoliaceae	Lonicera	maackii		
Caprifoliaceae	Lonicera	tatarica	Tartarian honeysuckle	
Caprifoliaceae	Sambucus	canadensis	Elderberry, common elder	
Caprifoliaceae	Symphoricarpos	sp.		
Caprifoliaceae	Symphoricarpos	orbiculatus	Common chickweed	
Caprifoliaceae	Triosteum	perfoliatum	Late horse gentian	
Caprifoliaceae	Viburnum	opulus	Guelder-rose	
Caryophyllaceae	Cerastium	sp.	Mouse-ear chickweed	
Caryophyllaceae	Dianthus	armeria	Deptford pink	

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Caryophyllaceae	Myosoton	aquaticum	Giant chickweed	
Caryophyllaceae	Silene	antirrhina	Sleepy catchfly	
Caryophyllaceae	Silene	pratensis	White campion, white cockle	
Caryophyllaceae	Silene	stellata	Starry campion	
Caryophyllaceae	Stellaria	longifolia	Stitchwort	
Caryophyllaceae	Stellaria	media	Common chickweed	
Celastraceae	Celastrus	scandens	Bittersweet	
Ceratophyllaceae	Ceratophyllum	demersum	Coontail, hornwort	
Chenopodiaceae	Chenopodium	album	Lamb's quarters	
Chenopodiaceae	Chenopodium	hybridum	Maple-leaved goosefoot	
Chenopodiaceae	Chenopodium	standleyanum	Woodland goosefoot	
Commelinaceae	Tradescantia	bracteata	Long-bracted spiderwort	
Commelinaceae	Tradescantia	ohiensis	Common spiderwort	
Convolvulaceae	Calystegia	sepium	American bindweed	
Cornaceae	Cornus	amomum	Silky dogwood	
Cornaceae	Cornus	drummondii	Rough-leaved dogwood	
Cornaceae	Cornus	racemosa	Northern swamp dogwood	
Cornaceae	Cornus	rugosa	Speckled dogwood	
Cornaceae	Cornus	stolonifera	Red-osier dogwood	
Cucurbitaceae	Echinocystis	lobata	Wild balsam apple	
Cupressaceae	Juniperus	virginiana	Red cedar	
Cyperaceae	Carex	blanda	Common wood sedge	
Cyperaceae	Carex	brevior	Plains oval sedge	
Cyperaceae	Carex	cephalophora	Short-headed bracted sedge	
Cyperaceae	Carex	comosa	Bristly sedge	
Cyperaceae	Carex	conjuncta	Green-headed fox sedge	
Cyperaceae	Carex	cristatella	Crested oval sedge	
Cyperaceae	Carex	davisii	Awned graceful sedge	
Cyperaceae	Carex	gravida	Long-awned bracted sedge	
Cyperaceae	Carex	grayi	Common bur sedge	
Cyperaceae	Carex	grisea		
Cyperaceae	Carex	haydenii	Long-scaled tussock sedge	
Cyperaceae	Carex	hystericina	Porcupine sedge	
Cyperaceae	Carex	lacustris	Common lake sedge	
Cyperaceae	Carex	laeviconica	Long-toothed lake sedge	
Cyperaceae	Carex	leavenworthii	Dwarf bracted sedge	
Cyperaceae	Carex	lupulina	Common hop sedge	
Cyperaceae	Carex	lurida	Bottlebrush sedge	
Cyperaceae	Carex	meadii	Mead's stiff sedge	
Cyperaceae	Carex	mesochorea	Short-headed bracted sedge	
Cyperaceae	Carex	molesta	Field oval sedge	
Cyperaceae	Carex	muskingumensis	Swamp oval sedge	
Cyperaceae	Carex	pellita	#N/A	
Cyperaceae	Carex	pensylvanica	Pennsylvania oak sedge	
Cyperaceae	Carex	sprengelii	Long-beaked sedge	
Cyperaceae	Carex	stipitata	#N/A	
Cyperaceae	Carex	stricta	Common tussock sedge	
Cyperaceae	Carex	tribuloides	Awl-fruited oval sedge	
Cyperaceae	Carex	trichocarpa	Hairy-fruited lake sedge	
Cyperaceae	Carex	vesicaria	Tufted lake sedge	
Cyperaceae	Carex	vulpinoidea	Brown fox sedge	
Cyperaceae	Carex	rosea/radiata	#N/A	

Cyperaceae	Cyperus	acuminatus	Short-pointed flat sedge	
Cyperaceae	Cyperus	filiculmis	Slender flat sedge	
Cyperaceae	Cyperus	strigosus	Long-scaled nut sedge	
Cyperaceae	Eleocharis	erythropoda	Red-rooted spike rush	
Cyperaceae	Eleocharis	ovata	Ovoid spike rush	Special Concern
Cyperaceae	Eleocharis	tenuis	Slender spike rush	
Cyperaceae	Hemicarpha?			
Cyperaceae	Scirpus	atrovirens	Dark green bulrush	
Cyperaceae	Scirpus	cyperinus	Wooly bulrush	
Cyperaceae	Scirpus	fluviatilis	River bulrush	
Cyperaceae	Scirpus	validus	Softstem bulrush	
Elaeagnaceae	Elaeagnus	angustifolia	Russian olive	
Equisetaceae	Equisetum	arvense	Common horsetail	
Equisetaceae	Equisetum	hyemale	Common scouring-rush	
Equisetaceae	Equisetum	laevigatum	Smooth scouring-rush	
Euphorbiaceae	Acalypha	rhomboidea	Three-seeded mercury	
Euphorbiaceae	Acalypha	virginica	Three-seeded mercury	
Euphorbiaceae	Euphorbia	corollata	Flowering spurge	
Euphorbiaceae	Euphorbia	nutans	Nodding spurge	
Fabaceae	Amorpha	fruticosa	Indigo bush, false indigo	
Fabaceae	Apios	americana	Ground-nut	
Fabaceae	Astragalus	canadensis	Milk vetch	
Fabaceae	Baptisia	lactea	White wild indigo	
Fabaceae	Chamaecrista	fasciculata	Partridge pea, locust-weed	
Fabaceae	Coronilla	varia	Crown vetch	
Fabaceae	Dalea	candida	White prairie clover	
Fabaceae	Dalea	purpurea	Purple prairie clover	
Fabaceae	Desmnanthus	illinoensis	Prairie mimosa	
Fabaceae	Desmodium	canadense	Showy tick-trefoil	
Fabaceae	Desmodium	paniculatum	Panicled tick-trefoil	
Fabaceae	Gleditsia	triacanthos	Honey locust	
Fabaceae	Glycine	max	Soybean	
Fabaceae	Lathyrus	palustris	Marsh vetchling	
Fabaceae	Lespedeza	capitata	Round-headed bush clover	
Fabaceae	Lotus	corniculatus	Bird's-foot trefoil	
Fabaceae	Medicago	lupulina	Black medic	
Fabaceae	Medicago	sativa	Alfalfa	
Fabaceae	Melilotus	alba	White sweet clover	
Fabaceae	Melilotus	officinalis	Yellow sweet clover	
Fabaceae	Robinia	pseudoacacia	Black locust	
Fabaceae	Trifolium	sp.		
Fabaceae	Trifolium	hybridum	Alsike clover	
Fabaceae	Trifolium	pratense	Red clover	
Fabaceae	Trifolium	repens	White clover	
Fabaceae	Vicia	cracca	Cow vetch	
Fagaceae	Quercus	alba	White oak	
Fagaceae	Quercus	bicolor	Swamp white oak	
Fagaceae	Quercus	borealis	Northern red oak	
Fagaceae	Quercus	ellipsoidalis	Hill's oak, northern pin oak	
Fagaceae	Quercus	macrocarpa	Bur oak	
Fagaceae	Quercus		Black oak	
Gentianaceae	Gentiana	andrewsii	Bottle gentian, closed gentian	

Geraniaceae	Geranium	maculatum	Wild geranium	
Haloragidaceae	Myriophyllum		Water milfoil	
Hippocastanaceae	Aesculus	glabra	Ohio buckeye	
Hydrophyllaceae	Ellisia	nyctelea	Waterpod, wild tomato	
Hydrophyllaceae	Hydrophyllum	virginianum	Virginia waterleaf	
Hypericaceae	Hypericum	canadense	Canadian St. John's wort	
Hypericaceae	Hypericum	perforatum	Common St. John's wort	
Hypericaceae	Hypericum	punctatum	Spotted St. John's wort	
Hypericaceae	Hypericum	pyramidatum	Giant St. John's wort	
Iridaceae	Iris	shrevei	Blue flag	
Juglandaceae	Juglans	nigra	Black walnut	
Juncaceae	Juncus	bufonius	Toad rush	
Juncaceae	Juncus	dudleyi	Dudley's rush	
Juncaceae	Juncus	tenuis	Path rush	
Lamiaceae	Agastache		Giant hyssop	
Lamiaceae	Glechoma	hederacea	Creeping Charlie, ground ivy	
Lamiaceae	Lamium	purpureum	Purple dead nettle	
Lamiaceae	Leonurus	cardiaca	Motherwort	
Lamiaceae	Lycopus	americanus	Water horehound	
Lamiaceae	Lycopus	asper	Rough water horehound	
Lamiaceae	Lycopus	uniflorus	Northern bugleweed	
Lamiaceae	Mentha	arvensis	Wild mint	
Lamiaceae	Mentha	x verticillata	Mint	
Lamiaceae	Monarda	fistulosa	Wild bergamot, horsemint	
Lamiaceae	Monarda	punctata	Spotted horsemint	
Lamiaceae	Nepeta	cataria	Catnip	
Lamiaceae	Physostegia		#N/A	
Lamiaceae	Physostegia	virginiana	False dragonhead	
Lamiaceae	Prunella	vulgaris	Self heal	
Lamiaceae	Pycnanthemum	virginianum	Common mountain mint	
Lamiaceae	Scutellaria		White skullcap	
Lamiaceae	Scutellaria	galericulata	Marsh skullcap	
Lamiaceae	Scutellaria	lateriflora	Mad-dog skullcap	
Lamiaceae	Stachys	hispida	Hispid hedge-nettle	
Lamiaceae	Stachys	palustris	Woundwort	
Lamiaceae	Stachys	tenuifolia	Smooth hedge nettle	
Lamiaceae	Teucrium	canadense	American germander	
Lamiaceae	Thalictrum	dasycarpum	Purple meadow-rue	
Lemnaceae	Lemna	minor	Duckweed	
Lemnaceae	Spirodela	polyrhiza	Greater duckweed	
Liliaceae	Allium	canadense	Wild onion	
Liliaceae	Asparagus	officinalis	Garden asparagus	
Liliaceae	Hemerocallis	fulva	Day lily	
Liliaceae	Lilium	michiganense	Michigan lily	
Liliaceae	Polygonatum	biflorum	Solomon's seal	
Liliaceae	Smilacina	stellata	Starry false Solomon's seal	
Liliaceae	Smilax	herbacea	Carrion flower	
Liliaceae	Smilax	hispida	Greenbrier	
Lythraceae	Ammannia	coccinea	Toothcup	
Lythraceae	Lythrum	alatum	Winged loosestrife	
Malvaceae	Abutilon	theophrasti	Buttonweed	
Malvaceae	Hibiscus	trionum	Flower-of-an-hour	

Menispermaceae	Menispermum	canadense	Moonseed	
Moraceae	Cannabis	sativa	Hemp, marijuana	
Moraceae	Humulus	japonicus	Japanese hops	
Moraceae	Humulus	lupulus	Common hops	
Moraceae	Morus	alba	Chinese mulberry, white mulberry	
Nymphaceae	Nuphar	luteum	Yellow water lily	
Oleaceae	Fraxinus	nigra	Black ash	
Oleaceae	Fraxinus	pennsylvanica	Red ash	
Onagraceae	Circaea	lutetiana	Enchanter's nightshade	
Onagraceae	Epilobium	coloratum	Cinnamon willowherb	
Onagraceae	Epilobium	leptophyllum	Bog willowherb	
Onagraceae	Gaura	biennis	Bienniel gaura	
Onagraceae	Ludwigia	polycarpa	False loosestrife	
Onagraceae	Oenothera	biennis	Common evening primrose	
Oxalidaceae	Oxalis	stricta	Yellow wood sorrel, lady's sorrel	
Plantaginaceae	Plantago	lanceolata	Buckhorn plantain	
Plantaginaceae	Plantago	major	Common plantain	
Plantaginaceae	Plantago	rugelii	Common plantain, Rugel's plantain	
Plantaginaceae	Plantago	virginica	Dwarf plantain	
Poaceae	Agropyron	repens	Quack grass	
Poaceae	Agrostis	gigantea	Redtop	
Poaceae	Agrostis	hyemalis	Ticklegrass	
Poaceae	Andropogon	gerardii	Big bluestem	
Poaceae	Bouteloua	curtipendula	Side-oats grama	
Poaceae	Bromus	commutatus	Hairy chess	
Poaceae	Bromus	inermis	Smooth brome	
Poaceae	Bromus	japonicus	Japanese brome	
Poaceae	Bromus	tectorum	Downy chess	
Poaceae	Calamagrostis	canadensis	Bluejoint	
Poaceae	Cinna	arundinacea	Wood reed	
Poaceae	Dactylis	glomerata	Orchard grass	
Poaceae	Dichanthelium	acuminatum	Panic grass	
Poaceae	Dichanthelium	latifolium	Broad-leaved panic grass	
Poaceae	Dichanthelium	oligosanthes	Heller's witchgrass	
Poaceae	Echinacea	pallida	Pale coneflower	
Poaceae	Echinacea	purpurea	Purple coneflower	Special Concern
Poaceae	Echinochloa	crusgalli	Barnyard grass	
Poaceae	Echinochloa	muricata	Spiny barnyard grass	
Poaceae	Elymus	virginicus	Virginia wild rye	
Poaceae	Elymus	canadensis	Canada wild rye	
Poaceae	Elymus	villosus	Slender wild rye	
Poaceae	Eragrostis	hypnoides	Pony grass	
Poaceae	Eragrostis	spectabilis	Purple lovegrass	
Poaceae	Eriochloa	villosa	Cup grass	
Poaceae	Festuca	arundinacea	Alta fescue	
Poaceae	Festuca	obtusa	Nodding fescue	
Poaceae	Glyceria	grandis	American manna grass	
Poaceae	Glyceria	striata	Fowl manna grass	
Poaceae	Hordeum		rye grass	
Poaceae	Hordeum	jubatum	Squirrel-tail barley	
Poaceae	Leersia	oryzoides	Rice cut-grass	
Poaceae	Leersia	virginica	Whitegrass	

Poaceae	Muhlenbergia			
Poaceae	Muhlenbergia	bushii	Short-leaved satin grass	
Poaceae	Muhlenbergia	frondosa	Wirestem muhly	
Poaceae	Panicum	capillare	Old witchgrass	
Poaceae	Panicum	dichotomiflorum	Knee grass, spreading witchgrass	
Poaceae	Panicum	virgatum	Switchgrass	
Poaceae	Paspalum	setaceum	Bead grass	
Poaceae	Phalaris	arundinacea	Reed canary grass	
Poaceae	Phleum	pratense	Timothy	
Poaceae	Phragmites	australis	Reed	
Poaceae	Poa	pratensis	Kentucky bluegrass	
Poaceae	Schizachyrium	scoparium	Little bluestem	
Poaceae	Setaria	faberii	Giant foxtail	
Poaceae	Setaria	glauca	Yellow foxtail	
Poaceae	Setaria	viridis	Green foxtail	
Poaceae	Sorghastrum	nutans	Indian grass	
Poaceae	Spartina	pectinata	Slough grass, cord grass	
Poaceae	Sphenopholis	obtusata	Prairie wedge grass	
Poaceae	Sporobolus	asper	Dropseed	
Poaceae	Tridens	flavus	Purple top	
Polemoniaceae	Phlox	divaricata	Sweet William, blue phlox	
Polemoniaceae	Phlox	maculata	Wild sweet William	
Polemoniaceae	Phlox	pilosa	Prairie phlox	
Polemoniaceae	Phlox	sp.		
Polygonaceae	Polygonum	amphibium	Water smartweed	
Polygonaceae	Polygonum	hydropiper	Water pepper	
Polygonaceae	Polygonum	lapathifolium	Curttop lady's thumb	
Polygonaceae	Polygonum	pennsylvanicum	Pinkweed	
Polygonaceae	Polygonum	persicaria	Lady's thumb	
Polygonaceae	Polygonum	punctatum	Water smartweed	
Polygonaceae	Polygonum	ramosissimum	Bushy knotweed	
Polygonaceae	Polygonum	sagittatum	Tearthumb	
Polygonaceae	Polygonum	scandens	Climbing false buckwheat	
Polygonaceae	Polygonum	virginianum	Jumpseed	
Polygonaceae	Rumex	acetosella	Red sorrel	
Polygonaceae	Rumex	altissimus	Pale dock	
Polygonaceae	Rumex	crispus	Curly dock	
Polygonaceae	Rumex	orbiculatus	Great water dock	
Polygonaceae	Rumex	verticillatus	Swamp dock	
Pontederiaceae	Pontederia	cordata	Pickerel-weed	
Potamogetonaceae	Potomageton	sp.		
Primulaceae	Lysimachia	ciliata	Fringed loosestrife	
Primulaceae	Lysimachia	hybrida	Loosestrife	
Primulaceae	Lysimachia	nummularia	Moneywort	
Primulaceae	Lysimachia	quadriflora	Narrow-leaved loosestrife	
Primulaceae	Lysimachia	thrysiflora	Tufted loosestrife	
Primulaceae	Lysimachia			
Ranuncaceae	Ranunculus	abortivus	Small-flowered crowfoot	
Ranuncaceae	Ranunculus	flabellaris	Yellow water crowfoot	
Ranuncaceae	Ranunculus	hispida	Hispid buttercup	
Ranuncaceae	Ranunculus	sceleratus	Cursed crowfoot	
Ranuncaceae	Ranunculus	septentrionalis	Swamp buttercup	

Ranunculaceae	Anemone	canadensis	Canada anemone	
Ranunculaceae	Anemone	virginiana	Tall anemone	
Ranunculaceae	Aquilegia	canadensis	Columbine	
Rhamnaceae	Rhamnus	cathartica	Common buckthorn	
Rosaceae	Agrimonia	gryposepala	Tall agrimony	
Rosaceae	Agrimonia	parviflora	Swamp agrimony	
Rosaceae	Crataegus	margaretta	Fireberry hawthorn	
Rosaceae	Crataegus	mollis	Downy hawthorn	
Rosaceae	Fragaria	virginiana	Wild strawberry	
Rosaceae	Geum	canadense	White avens	
Rosaceae	Geum	laciniatum	Rough avens	
Rosaceae	Malus	iowensis		
Rosaceae	Malus	sylvestris		
Rosaceae	Potentilla	arguta	Prairie cinquefoil	
Rosaceae	Potentilla	norvegica	Norwegian cinquefoil	
Rosaceae	Potentilla	recta	Sulphur cinquefoil	
Rosaceae	Potentilla	rivalis	Brook cinquefoil	
Rosaceae	Potentilla	simplex	Common cinquefoil	
Rosaceae	Prunus	americana	Wild plum	
Rosaceae	Prunus	serotina	Wild black cherry	
Rosaceae	Prunus	virginiana	Choke cherry	
Rosaceae	Rosa	sp.	Rose	
Rosaceae	Rosa	arkansana	Sunshine rose	
Rosaceae	Rosa	blanda	Meadow rose	
Rosaceae	Rosa	multiflora	Multiflora rose	
Rosaceae	Rubus	sp.		
Rosaceae	Rubus	allegheniensis	Blackberry	
Rosaceae	Rubus	occidentalis	Black raspberry	
Rosaceae	Spiraea	alba	Meadowsweet	
Rubiaceae	Cephalanthus	occidentalis	Buttonbush	
Rubiaceae	Galium	aparine	Cleavers	
Rubiaceae	Galium	obtusum	Wild madder	
Rubiaceae	Galium	triflorum	Sweet-scented bedstraw	
Rutaceae	Zanthoxylum	americanum	Prickly ash	
Salacaceae	Populus	deltoides	Cottonwood	
Salacaceae	Populus	tremuloides	Quaking aspen	
Salicaceae	Salix	amygdaloides	Peach-leaved willow	
Salicaceae	Salix	exigua	Sandbar willow	
Salicaceae	Salix	fragilis	Crack willow	
Salicaceae	Salix	nigra	Black willow	
Salicaceae	Salix	petiolaris	Meadow willow	
Salicaceae	Salix	rigida	Heart-leaved willow	
Saxifragaceae	Penthorum	sedoides	Ditch stonecrop	
Saxifragaceae	Ribes	americanum	Wild black currant	
Saxifragaceae	Ribes	missouriense	Wild gooseberry	
Saxifragaceae	Saxifraga	pensylvanica	Swamp saxifrage	
Scrophulariaceae	Agalinis	tenuifolia	Slender false foxglove	
Scrophulariaceae	Chelone	glabra	White turtlehead	
Scrophulariaceae	Gratiola	neglecta	Hedge hyssop	
Scrophulariaceae	Leucanthemum	vulgare	Ox-eye daisy	
Scrophulariaceae	Lindernia	dubia	False pimpernel	
Scrophulariaceae	Mimulus	ringens	Monkey flower	

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Scrophulariaceae	Pedicularis	lanceolata	Swamp lousewort	
Scrophulariaceae	Penstemon	digitalis	Foxglove penstemon	
Scrophulariaceae	Penstemon	grandiflorus	Large-flowered beardtongue	
Scrophulariaceae	Scrophularia	lanceolata	Early figwort	
Scrophulariaceae	Verbascum	blattaria	Moth mullein	
Scrophulariaceae	Verbascum	thapsus	Common mullein	
Scrophulariaceae	Veronica	officinalis	Common speedwell	
Scrophulariaceae	Veronica	peregrina	Purslane speedwell	
Scrophulariaceae	Veronicastrum	virginicum	Culver's root	
Solanaceae	Physalis	heterophylla	Ground cherry	
Solanaceae	Physalis	longifolia	Long leaf ground cherry	
Solanaceae	Solanum	americanum	Black nightshade	
Solanaceae	Solanum	carolinense	Horse nettle	
Solanaceae	Solanum	dulcamara	European bittersweet	
Sparganiaceae	Sparganium	eurycarpum	Common bur reed	
Typhaceae	Typha	angustifolia	Narrow-leaved cattail	
Typhaceae	Typha	latifolia	Common cattail	
Ulmaceae	Celtis	occidentalis	Hackberry	
Ulmaceae	Ulmus	rubra	Red elm, slippery elm	
Ulmaceae	Ulmus	americana	American elm	
Ulmaceae	Ulmus	pumila	Siberian elm	
Urticaceae	Boehmeria	cylindrica	Bog hemp	
Urticaceae	Laportea	canadensis	Wood nettle	
Urticaceae	Parietaria	pensylvanica	Pellitory	
Urticaceae	Pilea	pumila	Clearweed	
Urticaceae	Urtica	dioica	Stinging nettle	
Verbenaceae	Phyla	lanceolata	Fogfruit	
Verbenaceae	Verbena	hastata	Blue vervain	
Verbenaceae	Verbena	stricta	Hoary vervain	
Verbenaceae	Verbena	urticifolia	White vervain	
Violaceae	Viola	sororia	Hairy blue violet	
Vitaceae	Parthenocissus			
Vitaceae	Parthenocissus	vitacea	Woodbine	
Vitaceae	Vitis	riparia	Riverbank grape	
Vitaceae	Vitis	vulpina	Frost grape	

Appendix I

Ecological Assessment of Compensatory Wetland Mitigation
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Site	Date	DO	Temp	pH	Turb	Cond	TSS	DRP	Total P	NH3	Total N	NO3	SO4	Cl	COD
Engledinger															
13A	6/7/2005	10.6	30.3	8.04	3.2		11.2	0.19	0.45	BDL	BDL	0.33	9.35	11.36	61
13A	6/23/2005	13.2	30.7	7.36	4.0	477	2.4	0.19	NA	BDL	1.10	0.35	13.44	8.22	29
13A	7/5/2005	18.4	27.6	8.10	6.2	713	BDL	0.35	0.24	BDL	1.13	0.42	13.31	6.81	17
13A	7/18/2005	6.4	29.1	7.36	5.0	353	2.4	0.27	0.64	0.05	BDL	0.41	21.55	15.54	37
13A	8/2/2005	4.7	26.1	7.19	NA	553	NA	0.37	0.62	BDL	BDL	BDL	12.78	11.49	22
13A	11/26/2005	18.7	4.7	7.68	NA	390	NA	NA	NA	NA	NA	0.09	39.25	15.23	NA
13B	7/18/2005	20.9	28.5	9.64	41.4	148	67.3	0.31	4.11	0.37	13.44	0.41	3.71	13.40	197
13B	8/2/2005	15.4	27.3	8.91	NA	328	NA	0.13	2.47	0.23	8.53	BDL	3.51	14.99	141
13B	11/26/2005	24.3	3.2	8.18	NA	347	NA	NA	NA	NA	NA	BDL	22.63	27.90	NA
Hay-Buhr															
14NI	5/18/2005	8.0	12.5	7.16	2.8	395	BDL	0.17	0.19	0.05	8.51	7.82	26.10	25.69	22
14NI	6/1/2005	7.7	16.9	7.24	6.7	372	BDL	0.20	0.32	BDL	2.68	7.48	27.91	26.13	34
14NI	6/14/2005	5.9	16.6	7.19	3.4	409	BDL	0.18	0.25	BDL	13.07	9.86	21.73	32.45	60
14NI	6/28/2005	4.9	20.7	7.05	5.7	430	26	0.30	0.44	0.05	15.71	13.47	19.78	24.60	16
14NI	7/12/2005	5.8	21.6	7.27	5.5	376	BDL	0.25	0.22	BDL	6.68	5.86	30.41	25.23	12
14NI	7/28/2005	6.6	20.4	7.26	3.5	498	4.4	0.25	0.34	0.06	3.25	2.47	26.08	25.05	11
14NI	10/23/2005	10.2	8.8	7.44	2.7	504	BDL	NA	0.08	NA	6.32	8.77	34.63	27.93	NA
					4.3							7.96			
14SO	5/18/2005	9.0	14.5	7.45	1.5	374	BDL	0.08	0.23	0.07	7.94	6.91	25.95	29.91	48
14SO	6/1/2005	6.3	23.7	7.88	3.4	335	BDL	0.24	0.53	0.09	9.92	2.79	21.40	27.95	29
14SO	6/14/2005	2.7	19.9	7.04	3.5	369	BDL	0.26	0.51	0.07	5.53	9.90	21.63	32.25	58
14SO	6/28/2005	1.5	22.6	6.92	4.0	368	BDL	0.48	0.71	0.10	11.07	9.23	14.80	17.70	24
14SO	7/12/2005	5.9	23.8	7.20	4.2	388	BDL	0.25	0.24	0.07	5.27	3.68	22.59	28.63	18
14SO	7/28/2005	6.6	21.1	7.23	3.5	406	2	0.27	0.53	BDL	1.85	1.67	9.89	24.56	NA
14SO	10/23/2005	10.8	5.9	7.50	3.8	502	BDL	NA	0.27	NA	2.53	3.83	25.31	37.01	NA
South Point					3.5							5.43			
2I	5/25/2005	26.9	21.9	9.01	9.7	309	17	0.04	0.33	0.05	1.47	0.71	17.33	14.29	40
2I	6/7/2005	3.6	26.8	7.27	14.6	409	8	0.06	0.68	0.37	1.73	0.41	13.36	13.47	76
2I	7/5/2005	2.3	21.0	7.05	29.0	427	15.6	0.13	0.53	0.08	1.46	0.38	4.74	3.42	19
2I	7/18/2005	0.9	24.2	6.97	20.2	275	9.6	0.23	0.72	0.19	1.95	0.51	8.73	10.72	13
2I	8/2/2005	0.7	23.8	6.74	NA	404	NA	0.20	0.91	0.15	2.17	BDL	8.61	13.33	33
2I	11/26/2005	19.3	1.9	7.93	NA	285	NA	NA	NA	NA	NA	0.29	24.83	17.62	NA
												0.46			
2O	5/25/2005	13.9	21.2	8.39	11.7	364	11.5	BDL	0.34	0.05	2.28	1.82	18.93	14.83	36
2O	6/7/2005	11.5	25.7	8.45	20.8	403	18.4	0.04	0.64	0.06	BDL	0.65	17.74	16.49	85
2O	7/5/2005	14.1	28.4	8.77	10.1	560	5.6	0.04	0.25	BDL	1.86	0.61	10.48	9.50	19
2O	7/18/2005	7.0	27.9	7.86	12.6	311	4	0.05	0.52	0.05	1.88	0.47	10.23	11.92	27
2O	8/2/2005	11.3	24.7	8.33	NA	368	NA	0.06	0.78	0.07	2.17	0	10.58	14.91	51
2O	11/26/2005	19.3	1.2	8.00	NA	259	NA	NA	NA	NA	NA	0.30	23.57	16.76	NA
					12.2							0.64			
Pleasantville															
3	5/25/2005	6.9	20.6	8.69	29.7	133	38	0.16	0.74	0.06	1.34	0.34	1.91	6.40	65
3	6/7/2005	11.7	28.6	9.22	5.4	149	BDL	0.14	0.36	BDL	3.06	0.36	9.42	11.37	64
3	6/23/2005	7.8	28.5	8.82	7.1	157	BDL	0.21	0.69	BDL	2.65	0.36	1.40	5.63	70
3	7/5/2005	8.9	23.7	8.03	7.9	211	8	0.10	0.63	BDL	1.79	0.34	1.07	4.39	39
3	7/18/2005	3.8	24.5	6.84	24.0	169	8.4	0.07	1.19	0.06	3.31	0.41	1.69	7.51	54
3	8/2/2005	3.6	24.8	6.32	NA	262	NA	0.11	1.50	BDL	3.27	0	2.09	10.42	67
3	11/26/2005	17.3	2.1	6.35	NA	183	NA	NA	NA	NA	NA	0	2.73	18.95	NA
New Hampton					7.9										
4NEI	5/18/2005	8.3	10.2	6.77	9.5	563	2.5	0.29	0.84	0.17	9.58	0.43	24.67	23.20	24
4NEI	6/1/2005	13.3	14.8	7.38	27.0	532	16	0.17	0.65	0.21	14.47	13.43	20.76	41.90	26
4NEI	6/14/2005	8.9	14.0	7.19	5.0	437	BDL	0.22	0.29	0.20	15.33	1.63	19.44	34.24	23

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4NEI	6/28/2005	5.6	16.5	6.96	10.4	498	3.2	0.48	0.63	0.29	14.08	12.02	20.20	34.86	15
4NEI	7/12/2005	10.2	19.2	7.51	7.1	492	BDL	0.48	0.59	0.28	15.94	13.28	32.73	38.64	12
4NEI	7/28/2005	7.7	20.4	7.21	4.1	684	3.6	0.52	0.72	0.89	12.10	7.70	32.99	43.64	15
4NEI	8/9/2005	6.6	21.1	7.42	4.9	740	NA	0.56	0.75	0.45	11.98	10.31	46.51	54.45	12
4NEI	10/23/2005	9.8	10.4	7.51	3.8	611	39.6	NA	0.94	NA	8.68	5.07	23.09	28.22	NA
4NWI	5/18/2005	11.8	11.2	7.90	4.8	522	1.5	0.11	0.16	0.06	14.15	8.75	33.37	54.62	29
4NWI	6/1/2005	10.1	19.8	8.23	11.1	479	30	BDL	0.19	0.07	12.10	8.99	31.88	49.27	36
4NWI	6/14/2005	9.3	21.5	7.81	10.5	423	5.2	0.14	0.19	0.05	11.60	23.47	25.30	18.43	5
4NWI	6/28/2005	7.5	22.9	7.56	3.5	440	BDL	0.18	0.23	0.05	12.31	10.60	21.16	28.77	14
4NWI	7/12/2005	12.2	27.5	8.45	3.8	378	2	0.12	0.15	0.07	11.98	10.10	21.35	30.41	7
4NWI	7/28/2005	13.5	25.1	8.52	15.0	439	10	0.04	0.19	BDL	9.17	6.90	19.63	28.26	18
4NWI	8/9/2005	4.3	25.1	7.59	5.0	400	NA	BDL	0.10	0.20	7.81	6.43	24.52	33.68	23
4NWI	10/23/2005	10.5	10.5	7.78	10.4	439	11.6	NA	0.15	NA	4.21	6.71	22.18	29.20	NA
4SI	5/18/2005	7.3	11.5	7.51	6.0	556	2.5	0.52	0.59	0.42	7.36	0.44	24.65	23.24	34
4SI	6/1/2005	10.8	22.5	7.92	6.0	519	14	0.33	1.01	0.06	5.50	0.58	28.62	23.45	31
4SI	6/14/2005	4.1	17.6	7.41	6.6	390	3.2	0.28	0.65	0.49	7.13	1.70	9.37	12.78	40
4SI	6/23/2005	4.2	26.2	7.42	10.7	345	1.2	0.27	0.99	0.09	1.68	0.45	13.38	15.38	48
4SI	6/28/2005	3.2	18.8	7.35	7.8	431	6.8	0.77	1.24	1.62	9.90	5.04	18.19	21.67	23
4SI	7/12/2005	4.6	24.1	7.41	10.1	463	1.2	0.23	0.64	0.55	1.31	0.49	32.33	21.76	4
4SI	7/28/2005	6.3	19.9	7.34	14.4	565	3.6	0.48	0.92	1.39	4.01	0.77	24.14	21.93	4
4SI	8/9/2005	7.8	22.7	7.56	8.3	583	NA	0.34	0.86	0.53	BDL	0.48	26.07	20.51	11
4SI	10/23/2005	9.4	6.8	7.29	15.6	543	15.6	NA	0.68	NA	BDL	0.97	33.12	23.04	NA
4SO	5/18/2005	10.6	12.8	7.70	4.4	511	2.5	0.11	0.27	0.16	10.22	7.71	29.41	49.39	23
4SO	6/1/2005	10.9	20.4	8.48	4.4	402	NA	1.50	0.06	0.29	BDL	7.10	BDL	27.81	12.65
4SO	6/14/2005	7.1	22.5	7.45	3.9	445	BDL	0.15	0.35	0.57	6.00	11.10	25.48	35.47	25
4SO	6/23/2005	14.7	28.8	8.68	22.7	368	30.4	BDL	0.71	0.05	1.55	0.35	12.18	14.72	BDL
4SO	6/28/2005	6.0	23.2	7.18	7.9	451	3.6	0.30	0.78	0.49	9.37	7.48	19.10	26.88	16
4SO	7/12/2005	8.1	24.7	7.85	9.7	341	17.6	0.08	0.70	0.12	5.54	3.21	20.20	31.15	BDL
4SO	7/28/2005	6.0	21.5	7.41	5.8	417	5.6	0.23	0.51	0.87	5.10	2.59	18.00	26.77	17
4SO	8/9/2005	5.3	23.4	7.60	3.4	423	NA	0.24	0.44	0.27	BDL	0.86	20.92	32.25	16
4SO	10/23/2005	12.3	7.2	7.45	6.7	366	2	NA	BDL	NA	3.03	5.07	23.09	28.22	NA
Palisades					5.8							5.05			
6NI	5/18/2005	8.8	13.2	7.07	1.1	367	BDL	0.14	0.11	BDL	7.65	7.56	16.10	11.43	23
6NI	6/1/2005	8.2	17.3	7.40	3.7	343	15	0.05	0.18	BDL	7.42	6.55	15.95	11.32	BDL
6NI	6/14/2005	4.6	16.5	6.12	5.8	318	BDL	0.15	1.65	0.08	8.73	13.75	15.72	13.59	121
6NI	6/29/2005	5.4	17.5	6.55	1.0	376	BDL	0.05	0.35	BDL	6.63	5.61	15.04	12.90	35
6NI	7/12/2005	4.4	18.6	7.28	9.6	315	36	0.15	0.18	BDL	5.60	4.24	14.17	9.23	28
6SO	5/18/2005	15.1	17.7	9.06	9.7	236	5.5	0.17	0.76	0.13	1.22	0.54	12.24	11.74	34
6SO	6/1/2005	8.7	21.5	7.68	27.7	318	20.5	0.05	1.10	0.55	3.00	BDL	12.03	13.19	48
6SO	6/14/2005	3.3	24.5	7.43	7.9	320	BDL	0.06	0.23	0.40	1.87	24.76	26.45	38.01	77
6SO	6/29/2005	5.2	26.5	7.86	4.7	267	1.2	BDL	0.23	0.05	1.73	0.52	6.31	12.27	24
6SO	7/12/2005	3.4	26.3	7.53	8.8	188	2.8	BDL	0.19	BDL	BDL	0.39	5.26	11.85	25
6SO	7/28/2005	10.5	23.3	9.09	8.1	178	5.6	0.06	0.25	0.05	BDL	0.47	5.24	14.33	25
6SO	8/10/2005	0.9	25.9	7.76	189.0	203	NA	BDL	1.18	0.46	2.78	0.39	10.22	19.86	62

Wickiup Hill															
7	5/16/2006	7.89	12.51	7.88	55.9	423	52.4	BDL	1.39	0.414	2.4	0.3	20.7	3.9	46
7	5/30/2006	10.64	24.5	7.69	26.8	352	462.8	0.11	3.77	0.378	5.8	0.1	19.0	11.7	299
7	6/15/2006	1.38	19.1	7	98.9	341	107.6	0.24	1.53	1.434	6.8	0.2	11.8	14.6	160
Boevers															
8	5/16/2006	10.22	19.43	8.47	9.53	359	10.4	0.06	1.53	0.146	7.8	4.2	16.4	10.3	38
Badger															
9NW	5/25/2006	8.49	23.27	8	3.97	353	83.2	0.10	2.72	0.281	3.7	0.2	41.4	8.1	NA

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9SE	5/25/2006	7.17	22.58	7.85	3.19	173	175.6	0.19	3.14	0.756	4.4	0.1	14.3	3.3	NA
9	6/8/2006	5.52	24.57	8.1	106	533	31.6	0.09	1.06	0.063	NA	0.1	75.9	13.2	60
9	6/22/2006	6.15	27.34	7.95	149	641	106.4	0.69	1.86	0.367	BDL	0.3	>100	18.6	137
Mink															
10Eout	5/16/2006	9.65	19.21	8.3	4.31	265	6.8	0.02	1.29	BDL8	BDL	0.1	16.9	23.0	20
10E	5/30/2006	10.97	24.07	8.96	15.6	214	49.2	0.59	1.36	0.024	1.7	0.1	5.8	3.3	70
10E	6/15/2006	9.13	18.84	8.64	6.49	211	6.4	0.28	0.47	0.055	2.5	0.2	12.6	2.9	44
10E	6/29/2006	17.06	22.12	9.81	9.92	211	56.8	0.29	0.92	0.062	0.5	0.3	3.2	2.6	47
10E	7/13/2006	10.35	25.38	9.26	9.88	177	60.8	0.20	0.49	0.023	1.1	0.6	0.0	4.3	43
10E	7/25/2006	8.57	25.76	8.74	3.81	230	NA	0.34	NA	NA	1.6	0.2	6.9	5.0	32
10E	8/3/2006	13.01	27.22	7.66	29.3	398	46	0.25	2.63	0.069	4.0	0.2	4.2	4.9	44
					9.88										
10W	5/16/2006	11.25	16.5	8.6	5.71	329	6	0.08	0.99	0.07	BDL	0.1	19.3	20.2	12
10W	5/30/2006	11.08	24.6	8.99	7.69	223	BDL	BDL	0.04	BDL	0.7	0.1	16.3	2.8	12
10W	6/15/2006	10.01	19.85	9.24	4.34	139	8.4	0.03	0.03	0.026	1.0	0.2	14.9	3.1	19
10W	6/29/2006	15.24	24.62	9.99	10.8	199	12	0.06	NA	0.038	BDL	0.3	8.6	2.6	22
10W	7/13/2006	10.16	26.94	9.72	4.09	179	1.2	BDL	BDL5	BDL	1.1	0.1	5.2	4.1	25
10W	7/25/2006	9.91	23.57	9.7	1.88	198	NA	0.01	NA	NA	BDL	0.2	9.5	2.6	12
10W	8/3/2006	10.43	26.62	9.72	3.74	194	5.6	0.05	BDL	BDL	1.2	0.2	7.5	2.5	12
Brush															
11C	6/22/2006	1.55	20.84	6.5	21.2	2878	6.8	4.63	5.99	1.609	BDL	2.6	52.7	1050.0	29
11C	7/6/2006	0.4	18.35	7.1	14.9	1577	38	5.97	7.26	NA	5.0	0.7	18.3	371.0	39
11C	7/20/2006	0.31	22.56	7.08	14.4	2046	12.8	12.79	6.58	1.325	4.5	0.0	43.5	*158.5*	33
11I	5/25/2006	3.48	21.36	7.75	3.9	966	1.2	0.18	2.04	0.622	3.1	1.2	46.2	*200.6*	19
11I	6/8/2006	3.9	20.75	7.36	3.34	1385	BDL	0.28	1.46	0.459	4.0	0.5	39.3	*408.7*	23
11I	6/22/2006	0.34	20.8	6.95	16.9	1601	16	2.38	3.37	0.936	BDL	2.4	42.5	730.6	220
11I	7/6/2006	0.16	18.86	7.16	42.8	1364	44	4.85	6.40	NA	12.1	BDL	NA	277.0	42
11I	7/20/2006	0.15	23.67	6.85	10.5	1620	8	5.07	6.15	0.327	1.8	0.3	38.2	*113.2*	37
11I	8/3/2006	0.79	25.81	6.76	8.82	1155	11.2	4.52	7.56	0.713	3.7	0.2	36.4	*220.7*	39
11O	5/25/2006	7.51	22.35	8.87	2.64	758	1.6	1.53	0.37	0.578	1.3	0.3	49.9	*178.6*	19
11O	6/8/2006	1.76	23.2	8.94	1.54	857	1.2	0.32	1.16	0.09	2.6	0.1	27.4	*219.3*	25
11O	6/22/2006	1.85	23.46	8.64	3.48	927	4.8	1.63	2.02	0.09	BDL	2.4	23.2	220.0	27
11O	7/6/2006	1.16	20.66	7.89	10.9	1272	94	3.66	4.61	NA	5.4	BDL	NA	263.4	32
11O	8/3/2006	0.99	28.37	7.3	5.78	1196	28.4	4.01	9.92	0.338	7.7	0.3	33.4	*342.5*	92
					3.48										
11S	7/20/2006	0.26	24.74	6.58	20.2	2294	1284	18.66	8.50	1.688	11.2	BDL	90.8	*130.3*	268
Dike															
12I	5/16/2006	11.14	12.15	8.12	2.16	555	0.8	0.09	1.67	0.042	20.9	20.2	12.7	13.2	6
12I	5/30/2006	9.73	22.25	7.83	13.5	514	18.8	BDL	0.25	0.012	23.7	19.7	13.9	28.1	17
12I	6/15/2006	8.82	16.61	7.2	5.29	439	7.2	0.08	0.05	0.041	20.6	19.9	14.4	28.2	4
12I	6/29/2006	11.11	16.2	7.56	5.53	513	0.4	0.04	NA	0.045	24.4	18.8	11.5	24.5	7
12I	7/13/2006	8.29	17.09	6.98	8.73	466	8	0.06	0.05	BDL6	19.2	20.2	13.7	27.6	15
12I	7/25/2006	8.54	23.19	7.5	9.5	481	NA	0.03	NA	NA	5.3	4.7	15.3	28.2	14
12I	8/3/2006	7.92	18.82	6.62	7.01	563	13.6	0.11	0.04	0.018	14.1	13.4	17.6	25.8	BDL
												16.7			
12O	5/16/2006	10.05	13.15	8.14	8.86	532	24	BDL	1.19	0.082	21.6	20.6	13.0	13.1	14
12O	5/30/2006	6.92	24.49	7.92	4.88	434	1.2	0.04	0.12	BDL	18.0	14.1	13.3	28.9	10
12O	6/15/2006	8.38	20.11	7.77	2.75	322	2	0.02	0.06	0.068	13.5	10.8	13.1	30.2	11
12O	6/29/2006	7.28	22.53	7.58	27.7	NA	24.4	0.04	0.25	0.131	14.7	9.8	10.9	23.8	22
12O	7/13/2006	6.64	23.35	7.33	24.6	359	37.6	0.09	0.25	0.083	10.8	8.2	11.2	32.8	28
12O	7/25/2006	3.21	19.52	6.76	3.32	633	NA	BDL	NA	NA	0.2	0.2	18.1	29.9	24
12O	8/3/2006	5.96	24.82	7.56	19.2	419	33.2	0.07	0.46	0.143	4.7	2.4	10.0	23.2	24
Doolittle					8.86							9.4			
15	5/25/2006	7.1	22.21	7.65	27.7	166	21.6	2.97	4.29	0.043	2.9	0.1	2.5	1.3	187